THE CHILEAN ENERGY TRANSITION: THE ROLE OF POLITICS AND

POLICY IN ENABLING TRANSITIONS IN DEVELOPING COUNTRIES

By

CARLA A. CORONADO

A dissertation submitted to the

Graduate School-New Brunswick

Rutgers, The State University of New Jersey

In partial fulfillment of the requirements

For the degree of

Doctor of Philosophy

Graduate Program in Planning and Public Policy

Written under the direction of

Clinton J. Andrews

And approved by

____

____

____

____

New Brunswick, New Jersey

October, 2017

ABSTRACT OF THE DISSERTATION

The Chilean Energy Transition: The Role of Politics and

Policy in Enabling Transitions in Developing Countries

By CARLA A. CORONADO

Dissertation Director: Clinton J. Andrews

This dissertation studies the ongoing transition towards the use of renewable energy that commenced in Chile in the middle of the last decade. Chile is a developing country with high clean energy potential and a growing energy demand. The alignment of policies and economic and political conditions has already resulted in increased installed power generation capacity coming from renewable energy sources. Renewables, excepting large-scale hydropower, have grown from a negligible percentage to 17% of the mix by mid 2017.

Using insights from sustainability transitions studies, and the fields of policy analysis and economics, among others, this study aims to understand why this transition has come about, focusing on the analysis of three aspects: politics, policies and dynamics of the transition. The analysis is performed using mostly qualitative methods and complemented with available quantitative data. The study shows that while some of the key factors that allow the transition to occur are circumstantial, others might offer some room for agency and allow for transition steering. On the politics side, the study unravels the crucial role that the leaders of social organizations, —environmental non-governmental organizations and renewable energy industry associations, in particular— acting as policy entrepreneurs, played in the transition process by advocating for putting the renewables' issue on the policy agenda, pushing and lobbying the renewables' cause, and acting as advocacy coalition builders. On the policy side, the analysis shows that the government has also contributed to opening a new market for renewable energy generation technologies in the country by creating an energy policy strategy, implementing market regulations and developing the necessary institutional capacity for

materializing both policies and regulations. Moreover, the Chilean experience is found to be consistent with those of other pro-liberalization countries, seeming to indicate that completely liberalized electricity systems do not offer an adequate response to the sustainability challenges of our time, and that there is a need for balancing liberalization schemes by incorporating policy and planning measures that allow for steering systems into a socially desirable direction.

The study of the Chilean transition dynamics proves the general adequacy of sustainability transition theories —the Multi-Level Perspective in particular— for the analysis of transitions occurring in developing countries, highlighting the need to frame transitions approaches in a flexible way that contributes to the understanding of processes' dynamics while offering room for variation and novelty.

Despite all valuable progress, the Chilean energy transition has been limited to the adoption of new technologies developed elsewhere. However, the Chilean experience suggests that developing countries might embark on transitions by first adopting clean energy technologies and then transitioning towards adaptation and local technology-associated development. The renewables transition then represents an opportunity for Chile to continue to move towards more sustainable development.

ACKNOWLEDGEMENTS

"*The essence of sustainability lies in the recognition of agency in social choices about technological futures*." —Smith et al. (2005)

First and foremost I would like to thank Marcelo, my beloved husband, to whom I dedicate this work, for being my partner in dreams, adventures, tears and hard work. Without his support, none of this would have been possible. I thank my family in Chile, especially my parents Juan Carlos and Patty, who were always sending their support and love. I thank my friends from Chile, from Latin America, from the US and the world, who make me believe that a better world is possible and that it is worth to working hard to build it.

I want express my deep gratitude to Professor Clinton Andrews, my dissertation chair, for all his support and guidance through this Ph.D. journey. I also thank my dissertation committee, Professors Stuart Shapiro, Frank Felder and Maurie Cohen for their valuable insight and willingness to share their time with me. I also give many thanks to my professors at Rutgers University, especially Professors Robert Lake, Frank Fischer and Joseph Seneca, who inspired me and taught me precious knowledge gems that shaped my understanding and perspective. I also thank Professor Radha Jagannathan who taught me all the essentials of social science statistical methods, and with whom I had the privilege to work.

I also thank all the interviewees in Chile that kindly dedicated part of their valuable time for contributing to this research, and to all the operators of power plants in Northern, Central and Southern Chile, who were willing to host me and tour me through their workplaces. Many thanks also to all my friends and acquaintances in Chile who helped me to contact them; I am deeply grateful for all the coffees and teas we enjoyed together and for all their priceless help.

I also want to express my gratitude to the Becas-Chile program, from the Chilean National Commission for Scientific and Technological Research (CONICYT), who funded my doctoral studies. I am grateful for the opportunity that Chile, my country, offered me, prioritizing investing on my education and giving me the opportunity to live and learn from this doctoral adventure. I also thank the Fulbright Commission for the Beca Igualdad de Oportunidades (Equal Opportunities Scholarship program) that also sponsored my studies.

Many thanks also to the E.J. Bloustein School of Planning and Public Policy at Rutgers University, for offering me a Teaching Assistantship that also helped financing my Ph.D. program, and to the Center for Latin American Studies at Rutgers that supported me with funding for financing my dissertation fieldwork in Chile.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ABBREVIATIONS

ACERA	[Chile] Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*)
ACESOL	[Chile] Chilean Association of Solar Energy (in Spanish *Asociación Chilena de Energía Solar*)
ACHEE	[Chile] Chilean Energy Efficiency Agency (in Spanish *Asociación Chilena de Eficiencia Energética*)
ACHEGEO	[Chile] Chilean Association of Geothermal Energy (in Spanish *Asociación Chilena de Energía Geotérmica*)
ADEMAR	[Chile] Association of Marine Energy (in Spanish *Asociación Chilena de Energía Marina*)
APEMEC	[Chile] Association of Small and Medium Size Hydroelectric Generation Plants (in Spanish *Asociación de Pequeñas y Medianas Centrales Hidroeléctricas*)
CADE	[Chile] Electric Development Advisory Commission (in Spanish *Comisión Asesora para el Desarrollo Eléctrico*)
CAF	Latin American Development Bank
CBC	[Chile] Corporation of Capital Goods (in Spanish *Corporación de Bienes de Capital*)
CCTP	[Chile] Commission of Citizens, Technicians and Parliamentarians (in Spanish *Comisión Ciudadana Técnico Parlamentaria*)
CDEC	[Chile] Economic Load Dispatch Centers (in Spanish *Centro de Despacho Económico de Carga*)
CER	[Chile] Renewable Energy Center (in Spanish *Centro de Energías Renovables*)
CIFES	[Chile] Center for Innovation and Development of Renewable Energy (in Spanish *Centro de Innovación y Fomento de Energías Renovables*)
CNE	[Chile] National Energy Commission (in Spanish *Comisión Nacional de Energía*)

CODELCO	[Chile] National Copper Corporation of Chile (in Spanish *Corporación Nacional del Cobre de Chile*)
CORFO	[Chile] Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*)
CPUC	[US, California] California Public Utilities Commission
CREZ	[US, Texas] Competitive Renewable Energy Zone
CTF	Clean Technology Fund
ENAP	[Chile] National Petroleum Company (in Spanish *Empresa Nacional del Petróleo*)
FERC	[US] Federal Energy Regulatory Commission
FIT	Feed in Tariff
FTA	Free-Trade Agreement
GIZ	German Society for International Cooperation
HDI	Human Development Index
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation (World Bank Group)
INDH	[Chile] National Humans Rights Institute (in Spanish *Instituto Nacional de Derechos Humanos*)
IOMs	Industrial Opposition Movements
IPCC	Intergovernmental Panel on Climate Change
ISO	[US, California] Independent System Operator
ITA	[US] International Trade Administration
LCOE	Levelized Cost of Energy
LMP	Locational Marginal Princing
MLP	Multi-Level Perspective
NCRE	Non-conventional Renewable Energy

NDCs	National Determined Contributions
NGO	NonGovernmental Organization
NRDC	Natural Resources Defense Council
OECD	Organization for Economic Co-operation and Development
PPA	Power Purchase Agreements
PUCT	[US, Texas] Public Utility Commission of Texas
PURPA	Public Utility Regulatory Policies Act
RCA	[Chile] Environmental Qualification Resolution (in Spanish *Resolución de Calificación Ambiental*)
RE	Renewable Energy
RETI	[US, California] Renewable Energy Transmission Initiative
RHI	[UK] Renewable Heat Incentive
RO	[UK] Renewable Obligation
RPS	Renewables Portfolio Standard
SDGs	Sustainable Development Goals
SEIA	[Chile] Environmental Impact Assessment System (in Spanish *Sistema de Evaluación de Impacto Ambiental*)
SEC	[Chile] Superintendence of Electricity and Fuels (in Spanish *Superintendencia de Electricidad y Combustibles*)
SERC	[Chile] Solar Energy Research Center
SIC	[Chile] Central Interconnected System (in Spanish *Sistema Interconectado Central*)
SING	[Chile] Norte Grande Interconnected System (in Spanish *Sistema Interconectado del Norte Grande*)
SNM	Strategic Niche Management
TEP	Techno-Economic Paradigm
TIS	Technological Innovation Systems

TPMs	Technology- and Product-oriented Movements
TM	Transition Management
UN	United Nations
UNDP	United Nations Development Program
WWF	World Wide Fund for Nature

CHAPTER 1. INTRODUCTION

1.1. Introduction: the research problem

This research studies the ongoing transition towards the use of renewable energy that commenced in Chile in the middle of the last decade. Chile is a developing country with high clean energy potential and a growing energy demand. The alignment of policies and conditions has already resulted in an increase of the installed power generation capacity coming from non-conventional renewable energy sources.[1] Renewables, excepting large-scale hydropower, have grown from a negligible percentage to 17% of the current mix by April 2017, and the portion of electricity generated from non-conventional renewables is now reaching 15.7% of the mix in March 2017 (CNE, 2017).

My project is motivated by the recognition of the great environmental challenges of our time and by the acknowledgement that an urgent departure from current unsustainable practices is globally needed. My research focuses on the particular necessity of an energy transition, recognizing that the energy sector is considered to be one of the major causal agents of environmental degradation —climate change in particular— due to current generation and consumption practices. Many developed countries have already started to take action on this much needed global energy transition yet the developing world still lags behind. Nonetheless, the role that developing countries will play in that transition, and in particular the patterns of development they will follow, will determine how an eventual global transition to sustainability will unfold. Chile emerges as a leading developing country where the transition to renewable energies has already begun.

The case of Chile's transition is particularly interesting because it corresponds to a country where wind farms and solar PV technologies were introduced without incentives that supported their deployment, and yet they were able to compete successfully with conventional energy technologies. The Chilean transition was not one of envisioned transition management towards sustainability, rather it started mainly driven by energy security needs and the desire for economic efficiency. The

---

[1] Notably, the definition of *non-conventional renewable energy* (NCRE) is a particularly sensitive one in Chile. It was introduced in 2005 in the Short Act 1. The political sensitivity of the term will be explained in Chapter 2.

government initially followed a market failure approach, with the intention of opening a space for renewables to compete with incumbents in fair conditions. Environmental sustainability principles were considered relevant from the beginning, but they were not a core value embraced by Chilean energy policy, though they gained more and more prominence as the transition moved forward. Chile is a country where renewables entered the market when technologies were mostly mature, and the issues that surround their implementation do not relate to technological development, but rather reflect the reality of a developing country.

Chile's recent electricity transition has involved changes in multiple domains. First, it has implied a diversification of energy sources and a shift towards a less carbon-intensive electricity mix. There has also been a diversification of the actors in the electricity market and as a result, competition has increased in the sector which is now less concentrated, and that has yielded a consistent drop in electricity prices. The transition has also been related to changes in the way participation values are incorporated in energy policy-making as well as in the way the private sector develops generation projects, which both now reflect a much more participatory and inclusive approach. There has also been a change in the government's way of guiding and doing energy policy, a change from a model that relied on a liberalized market to one that involves more regulation and governmental planning.

This research project explores why this energy transition started and continues to develop in Chile. I describe and analyze the transition situated in its context, identifying relevant aspects that might have played a decisive role in determining the outcomes, as well as what actors have influenced the transition process and what motivations have driven them to take action. I explore in depth two specific aspects of the transition. First, I study how niches developed and the role that social organizations —environmental NonGovernmental Organizations (NGOs), NCRE industry associations, and social movements, in particular— have played in that process. I think they were responsible for opening windows of opportunity for socio-technical change to take place in the prevailing regime that was established in the Chilean electricity sector. Second, I explore the role that the Chilean government has played in modifying the existent regime by envisioning energy policy objectives, by creating new institutions in the energy sector, and especially by passing legislation and regulations that have modified the structure of the electricity market. I explore in particular how the structure of the electricity market has changed in the last decades due to regulations that have reshaped it, making it more suitable to receive new renewable energy technologies. This has resulted in an evolution from a completely liberalized market to one that involves more regulation.

I use a mixed methods approach to answer these questions. Data gathering methods contemplate document review, in-depth interviews and some quantitative analysis of energy, electricity and macroeconomic data. For understanding overall transition dynamics and studying transition pathways I rely on available sustainability transitions theories. Sustainability Transitions is an emerging field of literature that advocates for the need of a socio-technical change —a change that comprises a combination of technical, organizational, economic, institutional, socio-cultural and political changes— for shifting gears towards the achievement of a more sustainable economy. The field comprises a family of approaches that offer explanations of how transition processes to sustainability come about, and conceives that change is manageable to some extent, recommending several policy approaches for steering it. Among transitions theories, I think the Multi-Level Perspective (MLP) framework is adequate for understanding and explaining the underlying dynamics of the Chilean transition process. I use the MLP for interpreting transition dynamics and pathways, testing its consistency with the Chilean process of change, and trying as well to contribute back to the MLP theory from the lens of this case.

Overall, I expect that looking in depth at how the process of change towards energy sustainability has played out in Chile will allow me to shed light on the challenges and opportunities ahead of this transition. I aim to identify them and to make policy recommendations for a better undertaking of the transition in the Chilean energy sector, as well as for triggering and steering sustainable change in other socioeconomic domains. I also expect that my empirical findings will enable me to inform transition theories and make them more useful for understanding how changes come about in developing countries' contexts.

1.2. Framework for research

This section presents a theoretical basis for the study of the Chilean electricity transition. The first section examines electricity market structures and how their evolution has been shaped by economic development processes and ideologies. I explore in particular how the electric power sector in its evolution story has navigated multiple transition processes, and how its structure and established policies have favored the adoption of certain technologies. The analysis of that story helps to situate the problem of energy transitions to renewables, and to understand its causes and current hurdles.

Acknowledging the urgent need for a transition to sustainability that marks our era and the fact that anyway several obstacles have prevented the energy transition from happening, the following section presents a survey of renewable energy policies. This section includes a compendium of barriers that renewables face for entering the market, a summary of renewable energy policies that have been proposed for overcoming those barriers, and a brief discussion of existent barriers for renewable energy policymaking. This analysis is relevant for understanding the barriers that renewables' deployment face as well as the policy options that are available for overcoming them.

The third part of this section explores theoretical approaches on how transitions to sustainability come about, as proposed by the sustainability transitions research field. I review the main transition approaches and explore how they have been used for explaining energy transitions. The review of these approaches provides the broad theoretical context where the study of transitions to sustainability is situated, and the conceptual basis for understanding the research frameworks that will be addressed later in subsequent chapters.

Then I present a discussion on the theoretical research gap I identify from the literature that this dissertation study aims to help fill, and after that the section concludes by presenting the conceptual framework adopted to conduct my research study.

Literature discussions in this chapter are limited to the analysis of the overall context of energy/electricity systems and transitions. Future chapters will present further theoretical discussions allusive to their specific topics.

1.2.1. Electricity market structures: a story of business, policy and technology

The history of electricity markets has been marked by several transitions. It is a story of continuous and intertwined interactions between business interests, policy processes and technological development. Countries have learned from experience about how to deal with its management and evolving technologies and constraints. This section examines the evolution of electricity markets' structures through history.

Importantly, as the structure of electricity markets sets the context for electricity systems, it also sets the scheme for the adoption of renewables. Moreover, as Hirch (1989) argues, historical events provide the framework in which management decisions about policy are made. Looking at the evolution of electricity markets is then fundamental for understanding renewables' outcomes in the contexts of different countries.

<u>The emergence of regulation</u>

The story of electricity markets begins right after Edison created the first workable incandescent lamp in 1879 and launched the Edison Electric Light Company in the US. Samuel Insull, working for Edison's company, ideated a way of selling utility common stock to the public (Randolph and Masters, 2008). Insull realized the key importance for the electricity utility business of spreading the high fixed costs of facilities over many customers, as well as the relevance for the business of taking advantage of economies of scale for decreasing electricity prices and increasing profits. Recognizing the inefficiencies associated with the existence of multiple power companies competing for the same customers, and realizing that an industry with declining costs, high capital needs and intensive political interaction would gain stability and protection from regulation, he helped establish the concept of regulated monopolies with established franchise territories and prices controlled by public utility commissions. And this is how the economies of scale that went with increasingly large power plants led to an industry based on centralized generation, coupled with a complex infrastructure of transmission lines and distribution facilities.

Since then, the electricity sector was thought of as a natural monopoly due to physical reasons (economies of scale for generation plants, losses with long-distance transmission, impossibility to duplicate transmission and distribution networks, etc.), and electricity sectors almost everywhere in the world evolved with (primarily) vertically integrated monopolies. These monopolies were either state-owned, or privately-owned and subject to price and entry regulation by the state. Common practice was to integrate the primary components of electricity supply —generation, transmission, distribution, and retail supply— within individual electric utilities. Utility companies had then exclusivity to supply electricity to residential, commercial and industrial retail consumers within a defined geographic area.

Liberalization/deregulation

At the end of the twentieth century the scenario changed. A deregulation movement started in the 70s, as technological development in the sector had enabled the possibility of implementing competition. The motivation for energy market reforms was mainly driven by economic reasons to make the energy sector cost efficient through the introduction of competition among the players (Sioshansi, 2006), that was believed to lower energy prices and incentivize innovation. Other drivers for reform were political ideology on the faith of market forces, distaste for strong unions, the desire to foreign investment, and environmental concerns (Woo et al. 2003). And even strategic/political goals are decisive in some cases, as they were in the European Union (EU) restructuring of electricity markets in the 2000s (Karan and Kazdağli, 2011).

With the appearance of deregulation ideas, electricity started to be seen as a commodity, just as any other major standardized good, while during the regulation era, electricity was managed by countries or regions as a public good. In 1978, the Public Utility Regulatory Policies Act (PURPA) was approved in the US, which allowed non-utility generators to receive reasonable prices for the energy they produced, and is considered one of the first milestones of the deregulation wave that started later in the 80s and 90s (Randolph and Masters, 2008). In 1982, Chile started running the first modern spot market (Gan et al. 2014), within the dictatorship period that completely privatized and liberalized the Chilean electricity sector. After that in 1990 the UK privatized the Electricity Supply Industry in England and Wales establishing a pool-based electricity market that served many nations for many years as a market model. The initial UK action was followed by similar measures and led to a fully deregulated market in 1998, making the UK a pioneer in electricity deregulation. This example was soon imitated throughout the world and triggered efforts whose main common traits were: privatization of state-owned firms, vertical de-integration of utilities, allowance of new entry in the generation market and fully deregulate its prices, and the presence of an independent system operator responsible for reliable grid operation. Thereafter, the Nordic countries established their Nordic electricity market in 1994 that constituted the first multi-national spot market. After that, and with the interest of increasing the interconnectedness of European energy markets and building the common market, EU directives favored the liberalization of electricity and gas markets and promulgated the so called three packages of liberalization measures starting in 1996. Importantly, the second of these packages agreed in 2003 was aimed at achieving full opening of the electricity markets in July 2007 for all EU countries. The EU electricity sector though is still an object of critiques as many studies and authors report the existence of significant barriers to competition until today.

In the early 90s in the US the cost of electricity generated by independent power producers was far less than the average price of power charged by regulated utilities (Randolph and Masters, 2008), which motivated the Energy Policy Act of 1992 that allowed independent power producers to gain access to the transmission grid. Furthermore, in 1996, the Federal Energy Regulatory Commission (FERC) issued Order 888 for the elimination of anticompetitive practices in transmission services requiring investor-owned utilities to publish nondiscriminatory tariffs that applied for all generators, which were facing problems to get access to the transmission grid. Despite these reforms, the US has never enacted a mandatory comprehensive federal restructuring and competition law, leaving the most significant reform decisions to the states. Many US states have introduced liberalization reforms in wholesale markets. Among them stands out the Pennsylvania-New-Jersey-Maryland market that was created in 1998 and has also served as a worldwide market model, widely acknowledged to function properly reliably providing cheap electricity to consumers (Beneyto, 2010). Yet the case of the energy crisis in California in 2000 and 2001, a state that launched its deregulated electricity market in 1998, braked the deregulation momentum. Indeed, California, after experiencing its energy crisis due to widespread manipulation and misconduct on part of private providers, decided to back away from deregulation. This has created an undesirable air of caution among policymakers and proposals are now met with much greater skepticism, though many authors argue that the arguments in favor of a more competitive electric power industry remain attractive (Fox-Penner, 2014). As of today, 16 states plus the District of Columbia operate under deregulation reforms, yet other 7 states, including California, began the process of electricity deregulation in some capacity but have since suspended deregulation efforts.

Liberalization and deregulation reforms have taken place in different colors and flavors, and still many electricity markets or parts of them remain regulated. Importantly, in 1983 Joscow and Schmalensee published their book *Markets for Power*, in which they evaluated current popular options for deregulating the electricity sector and advised a balanced program for reform, advocating against total deregulation and recommending a cautious approach to even partial deregulation. Different countries have then pursued the liberalization and deregulation of their electricity markets in different ways, often creating/maintaining a regulator entity in charge of overseeing part of the electricity chain. A common policy of deregulation packages includes the creation of wholesale markets for power in order to provide incentives for lowering electricity costs, to encourage innovation in power supply technologies, to provide incentives for service quality, and to shift the risks of technology choice, construction cost and operating problems to suppliers and away from consumers (Joscow, 2008). Another big policy program of electricity deregulation reform is implementing retail competition for allowing consumers to choose a retail power supplier. The distribution and transmission sectors, whether privatized or not, have largely remained regulated as legal monopolies though reforms to traditional regulatory arrangements have generally been viewed as a key complement to the introduction of wholesale markets and retail competition (Joscow, 2008). Importantly, the regulation/deregulation process changes the allocation of risk and incentives, inevitably setting the framework in which future political and economic decisions are made.

Pollitt (2012) summarizes the evidence from the energy liberalization era arguing that in general market liberalization reforms are associated with improved efficiency, greater investment and access to services, but higher prices for at least some customer groups. So, on the one hand, energy liberalization has led to positive and globally widespread but modest efficiency gains across all energy sectors but a lack of clearly visible direct benefits to households in many countries. Indeed, the net gains are small, of the order of 5% of costs, which implies that price rebalancing and the raising of utility rates of return can easily leave some customers substantially worse off, especially poor consumers who were getting heavily subsidized (or even free) electricity. On the other hand, energy liberalization has significantly improved the governance of monopoly utilities (via independent regulators), the prospects for competition and innovation, and the quality of policy instruments for environmental emissions control (through the emergence of trading mechanisms). There have also been some failed reforms such as the California case that highlighted how difficult it was even for a developed country to get the appropriate package of reforms right.

Renewables, a new paradigm change

The introduction of competition propitiated the emergence of multiple generators located in different parts of the electricity grid that started to shape a decentralized electricity model. Along with this new distributed model, technological advances in the last decades enabled the development and incorporation to the grid of renewable energy technologies, among other generation alternatives (Assmann and Uh, 2006; Martinot, 2002).

More recently, new dominant paradigms have emerged in the world's energy agenda; the urgent need of stopping climate change and the necessity of guaranteeing energy security (Fox-Penner, 2014). With that, renewable energy sources for electricity generation have been recognized as the most suitable alternative for providing both a clean energy alternative and an endless source generation source. But renewables have faced several constraints for entering the electricity market related to cost and pricing barriers, legal and regulatory barriers and market performance barriers (Beck and Martinot, 2004). This is in part due to the fact that the structure of existent markets and the associated laws and institutions were developed when different technological paradigms and priorities dominated and have evolved according to technological and political constraints. But pressing sustainable energy needs are to be addressed with urgency, if climate-change goals are to be met (Sustainable Development Goals or the Paris Agreement), so different policy options have been proposed and political forces in different countries have been able to push to some extent the implementations of policy reforms in order to overcome the market entrance barriers that renewables face. These rules and regulations aim again at changing the electricity sector scenario by reallocating risk and creating incentives in favor of clean energy technologies, though results have been limited and much more effective and efficient efforts are needed (especially if climate-change goals are to be met).

From liberalization to re-regulation

In recent years, the need for shifting towards much cleaner energy technologies has focused attention on how the design of electricity markets may enable or prevent the transition to a low-carbon electricity system, while maintaining electricity security. The International Energy Agency (IEA) has argued that new environmental goals call for new power market designs (IEA, 2016). Moreover, the IEA (2016) report indicates that "competitive markets are an important tool, but they must be supplemented by regulation to ensure an effective transition to low-carbon power at least cost". This need has led countries to incorporate support policies and regulations for achieving renewable energy goals emerging due to the necessity of addressing existing barriers that prevent renewables from penetrating electricity markets. Pollitt (2012) notes that in the European Union concerns about emissions of greenhouse gases and energy security have led to pressure for more subsidized renewable electricity and less willingness to depend on the market to decide on investments within the energy sector from 2000. This has also been the case of countries and states that once were iconic promoters of market liberalization, such as the UK. Furthermore, the massive integration of renewables into countries/states energy mixes —e.g. California and Texas cases— have recently suggested the need for incorporating a planning component into countries' energy policy strategies that not only allows for steering the energy sector towards socially desirable outcomes but also to manage effectively the expansion and operation of the sector.

Major transitions though, rarely occur. Hughes (1983) argues that electric power systems, as socio-technical systems, have high momentum, force, and direction because of their institutionally structured nature, heavy capital investments, supportive legislation, and the commitment of know-how and experience. This momentum has been a conservative force reacting against abrupt changes in the line of development. But, Hughes also notes that though difficult to change, such systems are not autonomous, and then they should be possible to steer and shape.

Decisions on that steering become fundamental when Nye's (1992) reflection is considered; he remarks that the electrical system is an essential part of civilization that underlays most of its workings, whose adoption has had profound consequences for the total social construction of reality. He argues that every new technology is a social construction, and then people do not merely use electricity, but rather, the self and the electrified world have intertwined. Furthermore, Hirsh (1989), —talking about businesses in the sector, though also applicable to policy-making,— highlights the need for questioning the values, assumptions, and standard practices that have accumulated over time, while also highlighting the importance of strategizing considering technical and social consequences of incremental steps, which altogether affects decisions about the future of electricity systems.

Steering of electricity systems is to be implemented through policies and regulations. What is learned from the story of regulation and deregulation in the sector shed lights on how to proceed — indeed, Hirsh (1989) emphasizes that historical understanding can offer perspective for determining whether new situations pose novel challenges that require fundamental changes in (business) practices—. In this respect, Joscow and Schmalensee's (1983) analysis offers an early valuable insight which will be proven in line with posterior history of electricity systems and also with the results of this study (see Chapter 4): "any sensible deregulation scheme will require continuing economic regulation of some segment of the electric power system… Deregulation of the electric power industry cannot be complete. It must involve a mixture of regulation and competition." Indeed, they end their classic book with an encouragement for taking the most out of "both competition and effective, enlightened regulation."

1.2.2. Renewable energy policies

The evolution of the electric power sector in the world and the new urgencies of our time, especially related with climate change issues, have made it necessary for the sector to shift gears towards sustainability. Though urgently needed, several obstacles have prevented the energy transition from happening. Below I discuss barriers that renewables face for entering the market, I present a summary of renewable energy policies that have been proposed for overcoming those barriers, and address briefly existent barriers for renewable energy policymaking.

Barriers to renewable energy

Renewables have not been able to succeed in the market of electricity generation on their own. Their failure to enter the market has been mainly attributed to the existence of barriers, or conditions that prevent investment from occurring. The existence of the aforementioned barriers put renewable energy at a disadvantage relative to other forms of energy supply. Besides technological limitations or lack of cost-effectiveness pertinent to specific renewable energy technologies, Moomaw et al. (2011) have identified various common barriers and categorized them as: (1) market failures and economic barriers, (2) informational and awareness barriers, (3) socio-cultural barriers and (4) institutional and policy barriers.

Among the market failures that cause welfare losses due to the impotence of market forces to clear imperfections in the energy market are: the problems of un-priced environmental externalities of traditional energy sources that makes those technologies cheaper and then renewables less competitive; the existence of monopolies/monopsonies in energy markets that limits competition among suppliers/demanders and creates entrance/exit barriers to the market; and the absence of property rights that causes underinvestment in invention and innovation in renewable energy technologies. Other economic barriers relate to the access to financing. The financial structure of renewable energy projects is generally a problem, since they often have higher up-front investment costs and lower operating costs than traditional energy sources. This compounds with the lack of information related to risk, that results in overestimated economic and transactional costs. Additionally, beyond the uncertainty proper of electricity prices, the uncertainty around renewables gets negatively affected due to the fact that many technologies are in an early development phase (though the predictability of their costs is a relative advantage of renewable energy systems). The issue of scale also prejudices the financing options of renewable energy projects that tend to be smaller than traditional non-renewable energy sources, and then less attractive in terms of return rates than traditional energy generation projects which are much larger in scale.

There are also informational and awareness barriers such as the problem of deficient data about natural resources due to their site-specificity and the lack of skilled human resources (capacity). Additionally, the limited public and institutional awareness of the technical and financial issues related to implementing an energy transition, which tends to overestimate the costs of a transition.

Socio-cultural concerns linked to societal and personal values and norms might affect the perception and acceptance of RE technologies (although, this is an issue that also affects conventional energy technologies). Socio-cultural barriers may relate to potential negative impacts on behavior, natural habitats and natural and human heritage sites. This includes impacts on biodiversity and ecosystems, landscape aesthetics, and water/land use and water/land use rights, as well as their availability for competing uses.

Institutional and policy barriers include energy market regulations that might have evolved around monopoly providers and technical regulation and standards that were designed for large centralized energy systems. The absence of patents may discourage private investment in R&D, but at the same time the existence of patents may restrict low-cost access to new technologies by developing countries. Tariffs in international trade imposed by some countries also reduce trade in some renewable energy technologies. The allocation of government financial support has been biased towards non-renewable energy sources.

Policies to encourage renewable electricity generation

Several demand-pull policies of different types have been suggested in the literature for creating demand for renewable energy in the marketplace. The pool of policies includes fiscal incentives, public financing tools and regulatory policies. A summary of available policies is presented in Table 2 (Mitchell et al., 2011).

Table 1.1. Policies to encourage deployment of renewable electricity generation.

Policy	Definition
Fiscal incentives	
Grant	Monetary assistance that does not have to be repaid and that is bestowed by a government for specified purposes to an eligible recipient. Usually conditional upon certain qualifications as to the use, maintenance of specified standards, or a proportional contribution by the grantee or other grantor(s). Grants (and rebates) help reduce system investment costs associated with preparation, purchase or construction of renewable energy (RE) equipment or related infrastructure. In some cases, grants are used to create concessional financing instruments (e.g., allowing banks to offer low-interest loans for RE systems).
Energy production payment	Direct payment from the government per unit of RE produced.
Rebate	One-time direct payment from the government to a private party to cover a percentage or specified amount of the investment cost of a RE system or service. Typically offered automatically to eligible projects after completion, not requiring detailed application procedures.
Tax credit (production or investment)	Provides the investor or owner of qualifying property with an annual income tax credit based on the amount of money invested in that facility or the amount of energy that it generates during the relevant year. Allows investments in RE to be fully or partially deducted from tax obligations or income.
Tax reduction/exemption	Reduction in tax—including but not limited to sales, value-added, energy or carbon tax—applicable to the purchase (or production) of RE or RE technologies.
Public finance	
Investment	Financing provided in return for an equity ownership interest in a RE company or project. Usually delivered as a government-managed fund that directly invests equity in projects and companies, or as a funder of privately managed funds (fund of funds).
Guarantee	Risk-sharing mechanism aimed at mobilizing domestic lending from commercial banks for RE companies and projects that have high perceived credit (i.e., repayment) risk. Typically a guarantee is partial, that is, it covers a portion of the outstanding loan principal with 50 - 80% being common.
Loan	Financing provided to a RE company or project in return for a debt (i.e., repayment) obligation. Provided by government, development bank or investment authority usually on concessional terms (e.g., lower interest rates or with lower security requirements).
Public procurement	Public entities preferentially purchase RE services (such as electricity) and/or RE equipment.
Regulations	
Quantity-driven	
Renewable Portfolio Standard (RPS)/Quota obligation or mandate	Obligates designated parties (generators, suppliers, consumers) to meet minimum (often gradually increasing) RE targets, generally expressed as percentages of total supplies or as an amount of RE capacity, with costs borne by consumers. Building codes or obligations requiring installation of RE heat or power technologies, often combined with efficiency investments RE heating purchase mandates. Mandates for blending biofuels into total transportation fuel in percent or specific quantity.
Tendering/Bidding	Public authorities organize tenders for given quota of RE supplies or supply capacities, and remunerate winning bids at prices mostly above standard market levels.

Price-driven	
Fixed payment Feed-In Tariff (FIT)	Guarantees RE supplies with priority access and dispatch, and sets a fixed price varying by technology per unit delivered during a specified number of years.
Premium payment FIT	Guarantees RE supplies an additional payment on top of their energy market price or end-use value.
Quality-driven	
Green energy purchasing	Regulates the supply of voluntary RE purchases by consumers, beyond existing RE obligations.
Green labeling	Government-sponsored labeling (there are also some private sector labels) that guarantees that energy products meet certain sustainability criteria to facilitate voluntary green energy purchasing. Some governments require labeling on consumer bills, with full disclosure of the energy mix (or share of RE).
Access	
Net metering (also net billing)	Allows a two-way flow of electricity between the electricity distribution grid and customers with their own generation. The meter flows backwards when power is fed into the grid, with power compensated at the retail rate during the 'netting' cycle regardless of whether instantaneous customer generation exceeds customer demand.
Priority or guaranteed access to network	Provides RE supplies with unhindered access to established energy networks.
Priority dispatch	Mandates that RE supplies are integrated into energy systems before supplies from other sources.

Source: Mitchell et al. (2011).

Barriers to renewable energy policymaking

There are also numerous barriers to the successful policy-making, implementation and financing of renewable energy policies that have also been summarized by Mitchell et al., 2011. Barriers to making and enacting policy include: lack of information and awareness about renewable energy resources, technologies and policy options; lack of understanding about policy design or how to undertake energy transitions; difficulties associated with quantifying and internalizing external costs and benefits, and lock-in to existent technologies and policies. Once policies are enacted, challenges can arise related to implementation. These include conflicts with existing regulations; lack of skilled workers; and/or lack of institutional capacity to implement renewable energy policies. Even when policies get implemented, financial barriers still prevent the achievement of the desired renewables' development. As was mentioned above, financing of renewable energy projects get prejudiced by the risk perceived as associated with future price tendencies, by the financial structure of renewables projects that requires high investment costs and lower operating costs, and the issue of scale because renewables project often are small, among others.

Renewables' deployment in Chile versus in other countries

Most Western European countries have implemented combined schemes of feed-in tariffs, feed-in premiums, quotas and/or tenders for incentivizing renewables' deployment. Many states in the US have also implemented incentives for advancing the transition to clean energy. The case of Chile is different, as it is a country where renewables were able to enter the market successfully without the presence of subsidies. The Chilean government unleashed that following a market failure approach; certain market failures and barriers that prevented renewables' deployment were identified and the government decided to implement a modest renewable energy quota requirement. As renewables started entering the market, the amendment of certain regulations and laws became increasingly necessary if Chile was to continue to enable and foster renewables' development. Indeed, it turned out that the electricity sector started shifting from a model that relied almost entirely on the invisible hand of the market, to one that comprised increasing government planning.

1.2.3. Sustainability transitions theories

This section explores theoretical approaches proposed from the sustainability transitions research field that aim to understand how transitions to sustainability come about for explanatory and prescriptive purposes.

Researchers from this field have noted that addressing the sustainability challenges of our time will require deep-structural changes that have been called "sustainability transitions" or "socio-technical transitions to a sustainable economy", because they will comprise a combination of technical, organizational, economic, institutional, socio-cultural and political changes. These transitions have been characterized as complex long-term processes that involve the interaction of multiple actors and institutions (Markard et al., 2012). Moreover, they do not come about easily because existing unsustainable systems (e.g. in energy or transport sectors) are stabilized by lock-in mechanisms (e.g. increasing results to scale) that create path dependencies making difficult to dislodge existing systems (Geels, 2011). This lock-in relates, among other factors, to scale economies, sunk investments, vested interests, infrastructure, and regulations, as well as to institutional commitments, shared beliefs and discourses, power relations, and political lobbying (Unruh, 2000). Additionally, consumer practices, life styles and preferences may become adjusted to existing systems. As a consequence, established socio-technical systems undergo incremental rather than radical changes, and incremental change is not believed to lead to sustainability fast enough as needed (Markard, 2012).

Claiming the need for radical, large-scale socio-technical changes, and acknowledging the key role of technology in such processes, the emergent field of *sustainability transitions* aims at understanding transition processes with the objective of proposing policy options and planning strategies for shifting gears in a (more) sustainable direction. The field emerges as an alternative to the classic response strategies to environmental problems that are considered insufficient, e.g. current economic approaches that have not been able to generate the necessary incentives to produce a change in the pace needed.

Researchers in the area of socio-technical transitions suggest that transitions towards sustainability are "somehow manageable", and the research field of sustainability transitions is built on that assumption. Importantly, one particularity of the transitions approach is that it assigns governance a critical role, so political actors and regulatory and institutional support are expected to be key agents in a guided transition process (Smith et al., 2005). Researchers in this field believe that the policy-induced character of transitions corresponds to the most suitable alternative for pursuing sustainability.

Many theoretical frameworks have emerged in the sustainability transitions literature, yet so far the field does not have a unifying theory that groups all of them. Approaches generally share the guiding principles of the field described above. Among the most commonly used approaches for understanding transitions are the Technological Innovation Systems (TIS) approach and the Multi-Level Perspective (MLP). The TIS literature focuses on analyzing the development, diffusion and use of a particular technology (innovation) through a network of actors and institutions. The MLP is a framework for studying the global dynamics of a transition process, defined as a regime shift, that results as an outcome of the interacting processes between three analytical levels: niches (micro), socio-technical regimes (meso) and socio-technical landscapes (macro).

As the field has an explicit focus on policy, researchers have also proposed governance strategies for managing transitions based. The Strategic Niche Management (SNM) represents a policy vision on how to induce transitions based on the development of niches or protected spaces (from MLP theory), which are to be real-world experiments in the form of pilot and demonstration projects that may provide the space for path-breaking innovations to grow and potentially scale-up, acting as building blocks for achieving broader societal changes (van den Bergh et al., 2011). There is also the transition management (TM) policy framework developed from 2001 onwards by the Dutch Ministry of Economic Affairs in The Netherlands (Kemp and Loorbach, 2003), which is more of a prescriptive approach for steering sustainable transitions based on insights from governance and complex systems theory. The TIS approach also counts with a recommended strategy for managing transitions that is based on the definition of a set of functions that an innovation system is expected to provide, and whose lack corresponds to certain system failures that needs to be addressed.

Some of these approaches are described in detail and used for informing the discussion in later chapters.

Explaining energy transitions

In general, the MLP and the TIS theories focus on understanding transitions' dynamics, while the TM approach as well as SNM studies focus more on developing strategies for managing and advancing transitions. The TM theory, the MLP and the SNM approaches have been used for analyzing the Dutch energy transition to renewables from different angles (Kemp et al., 2007; Kemp, 2011; Kern and Howlett, 2009). The TIS approach has been applied for explaining the transition to solar PV in Germany (Jacobsson and Bergek, 2011). The MLP has been used for analyzing and comparing the German and English transition towards the use of clean energy sources (Geels et al., 2016). Notably, the sustainability transitions research theories have been mostly applied to developed countries' contexts, and then essentially for "cleaning" purposes in the contexts of countries with strong institutions and a well-established rule of law. In that sense, it is of special interest to study them embedded in different realities, such as countries with more limited resources, or regions with different governance and institutional structures.

One particular research need common to transitions theories is gaining a better understanding of the policies and politics of transitions, as Rogge and Reichardt (2016) pointed out. This is one of the aspects that this dissertation expects to contribute to. I elaborate on this in the following section.

1.2.4. Conceptual framework for this research

This research begins acknowledging the big sustainability challenges of our era, which comprise economic, environmental, social and institutional (governance) challenges. The study is framed from a sustainability transitions perspective. This means that I understand sustainability transitions as comprising multi-dimensional socio-technical change processes, which are highly context-dependent and complex. I start with the assumption that transitions to sustainability can be steered and managed to a certain point, as I agree with Smith et al. (2005) on thinking that "The essence of sustainability lies in the recognition of agency in social choices about technological futures".

The study that I develop in this dissertation aims at exploring the ongoing electricity transition towards the use of renewable energy that has started to take place in Chile around 2005. While I acknowledge that the multidimensionality, complexity and context-dependency of transition processes makes them largely irreproducible, I argue that there are certain features of the process that can offer some insights on what can be done by actors for enabling or facilitating their occurrence. Then, I focus the study on aspects that can potentially offer some agency to maneuver for stakeholders in (energy) transition processes.

This research will comprise a compilation of the events that have taken place from 2004 until late 2016, trying to link them and find explanation of what motivated actors to take certain actions. Such a survey of historical events will help me to identify what has changed in the Chilean energy sector across the last decade, and why such changes have taken place. I will take a closer look at the role that social organizations and the Chilean government have had in the transition process. Informed by that analysis I will then analyze the overall transition dynamics of the Chilean transition.

I expect the analysis enables me to both make political and theoretical contributions. At the policy level I expect to both being able to document the Chilean transition —which corresponds to a novel study that has value in itself— as well as to identify transition challenges to the further development of the Chilean transition to renewables. This will hopefully enable me to make prescriptive policy suggestions on how Chile should proceed to continue to advance renewables' deployment. The expected theoretical contributions to the study of transitions are described in the section that follows.

1.2.5. The research gap to be addressed

The study of transitions dynamics so far has mostly comprised analyses of transitions that have occurred in developed countries, principally in Western Europe where the field of sustainability transitions first emerged. Available studies so far are mostly situated in the context of developed economies that enjoy economic resources and political stability, as well as a consolidated rule of law and strong public institutions. There is though, a gap with respect to how transitions occur in developing countries which are characterized by significantly different contexts with much less resources and less strong institutional frameworks. Moreover, the transitions literature is generally linked with literature on technological innovations, as European countries started subsidizing clean energy technological development motivated by sustainability and environmental convictions. In contrast, developing countries have not been willing to invest their scarcer resources in technological development and innovation, as they have other social priorities.

The Chilean case is an example of a transition that did not occur because of the existence of subsidies. It is a transition that did not involve technological development so far, but only the implementation of new available technologies coming from the developed world. In that sense, available transition theories have not been broadly tested against transition processes that occur in developing countries contexts and do not involve significant technological innovation. Available theories then do not fully account for the different dynamics of such transition processes and need to be further developed in order to be adequate for understanding and prescribing recommendations for them. Through the lens of the Chilean empirical case, this research seeks to contribute to the theoretical understanding of transition dynamics that occur in the context of developing economies, which ultimately aims at shedding light on how to trigger and steer such transitions.

A particular aspect that the Chilean transition allows us to explore is how policy processes affect the development of transitions. This also corresponds to an aspect of transition studies that has not been much developed. Indeed, there is a need for studying how different stages of policy processes impact transition dynamics leading to one or another transition pathways. In that sense, this study seeks to explore the link between theoretical approaches from the policy analysis and transitions research fields. Importantly, this type of analysis is common ground to all transition approaches and its study might provide useful insights for both the understanding of transition processes and the prescription of policy strategies to address them.

Another aspect that I will take a closer look at is the role that governments play in enabling and steering transition processes. This aspect of transitions has been more studied by researchers in the field, especially those that promote the TM approach, but again available studies are generally contextualized in the reality of Western European countries with strong welfare states, that are quite used to state guidance and intervention. In that sense, the case of countries that have much less strong governments and are characterized by more liberal economic ideologies remains underdeveloped. The Chilean transition is useful for exploring the planning role that the government has played in the transition, and how that role has evolved over time. I expect to analyze the state's role as a policy visionary, as an operational enabler through the creation of institutions, and as a market regulator. Indeed, the case of Chile is particularly interesting because this evolution has led the country from a liberalized electricity market to one with increasing regulation and state intervention. I expect the case study of Chile sheds light on how governments may affect and enable transitions by intervening in predominant regimes, as well as on how that role might be used for managing and steering transitions.

1.3. Approach and methodology

This section describes the research approach that I adopted for performing the study including research questions and their respective tentative hypotheses, as well as the methods selected for addressing each of them.

1.3.1. Research questions and hypotheses

This study is motivated by an overall research question and a set of three specific sub-questions that point towards specific aspects of the transition that this study examines. The general question describes in a general way the overall case and the events that had taken place in the energy sector in the last decade in Chile, as well as assessing whether available transition theories offer suitable explanations for what has been happening in the ongoing Chilean case.

The sub-questions are posed in an attempt to look deeper into specific aspects of this transition, specifically the role of social organizations and the government in the transition process, as well as for assessing challenges for the future development of the renewables' sector in Chile. Though I acknowledge that I am deliberately deciding to leave aside other interesting aspects —say the role of international support in its multiple forms or the importance of international trends,— mostly due to time constraints, I picked to study those that I think offer the most replicable agency potential for pushing transitions forward.

The questions are presented below along with tentative answers to them that reflect the researcher's perspective on how each of the referred aspects of the transition might have played out in the Chilean transition process. Most questions involve a descriptive and an explanatory component.

Overall question:

Why has a transition process towards the use of renewable energy unfolded in Chile during the last decade? What does the empirical evidence from the Chilean case tell about how and why transition processes come about?

This question attempts to describe the overall story of the Chilean transition towards the use of renewable energy that started to happen during the last decade, as well as to assess whether available transition theories might offer an adequate explanation of the Chilean case. This question has a descriptive and an explanatory component.

The descriptive component attempts to tell the overall story of the change towards the use of renewables that has started to happen in Chile. Importantly, there is special value of putting together and organizing the pieces of this story, especially because it has not been documented yet in the literature. This part of the study might be potentially relevant for Chilean policy-making in the energy and other sectors. This part will comprise a characterization of the overall case, including a description and analysis of specific changes that reflect the energy transition in Chile, the identification of the different groups of actors that have been involved in the process as well as their specific motivations, and a characterization of the overall Chilean context (availability of natural resources, electricity market structure, economic model, macroeconomic conditions, development stage, political context, etc.) along with a description of specific contextual factors that might have allowed the transition to happen (international aid, international tendencies, energy demand, energy prices, availability of financing, etc.).

The explanatory component of the research question attempts to assess whether the available transitions theories —the Multi-Level Perspective framework in particular, coming from the Sustainability Transitions Research field— is adequate for explaining (part of) the Chilean case. I also expect my empirical findings allow me to inform the theoretical discourse on how transitions come about in developing countries' contexts.

<u>Specific sub-questions:</u>

<u>Sub-question 1:</u> *What has been the role of social movements and organizations in opening up windows of opportunity for socio-technical change towards the use of renewable energy in Chile and why did they decide to engage in the transition process in the ways they have?*

Hypothesis 1: Civil society organizations —including advocacy groups, industry associations and larger social movements— have played a crucial role in the Chilean energy transition, enabling socio-technical change to take place in the prevailing regime that was established in the Chilean electricity sector.

Framing the case from a MLP approach, this question focuses on the space of interaction dynamics between niches and regimes, and argues for social movements as enablers for niches to break-through the existent socio-technical regime. Indeed, I think social organizations were responsible for opening up windows of opportunity for socio-technical change to occur. I will describe and explore the role of these groups on the transition, and analyze as well how political dynamics have affected it.

Sub-question 2: What has been the role of the Chilean government in the energy transition taking place in Chile and why has it acted in such ways? In particular, how have regulations modified the structure of the electricity market and in which ways this has affected the transition?

Hypothesis 2: The Chilean government has played a significant role in enabling the transition towards the use of renewables in Chile to start happening, by envisioning energy policy objectives, by the creation of new institutions in the energy sector, and especially through the reshaping of the electricity market via legislative reforms. In particular, the implementation of regulations has changed the structure of Chilean electricity markets in the last decades forcing the system to adapt from one that had originally been designed for and evolved accordingly to traditional energy sources, to one that is more suitable to receive non-conventional renewable energies and allow them to compete with the incumbents in fairer conditions. This has resulted in an evolution from a completely liberalized market to one that involves increasingly more regulation.

I think the Chilean government, through the creation of institutions and implementation of policy strategies and regulations — that have coupled with favorable contextual factors, such as energy prices and demand projections— have created the conditions (a sort of protected space or niche) that have allowed the renewable energy market to develop.

<u>Sub-question 3:</u> What challenges are ahead for the Chilean energy transition? Based on obtained findings and theoretical analyzes, what recommendations might be useful for future energy policy-making in Chile?

This question focuses on identifying the challenges that are ahead of the ongoing energy transition in Chile. A priori I observe that the Chilean electricity system as a whole suffers from transmission problems. Additionally, the development of electricity projects encounters serious difficulties to get social acceptance. NCRE projects generally face less opposition than conventional technologies, but protests and delays still occur. In addition to that, there is the fact that the development of the energy sector in Chile depends on the development of the mining sector, and that makes the transition to depend on its development as well.

I also expect this part of the study, along with the analysis of previous questions, will allow me to characterize both the most likely future of the transition and what I think it would be most desirable one to happen, in order to make policy recommendations based on the findings.

Figure 1.1. Fieldtrip map.

1.3.2. Methods

For undertaking the study of the Chilean energy transition I use a mixed methods approach, combining qualitative and quantitative analyses as appropriate for answering each one of the research questions. Data gathering methods have included document review (record-based analysis), in-depth interviews and some quantitative analysis of energy, electricity and macroeconomic data of Chile. For exploring the Chilean transition I explore documents and conduct interviews in both in English and Spanish. The data analysis is mainly done through direct interpretation and it will be presented in a narrative style, along with relevant statistics and any numerical results deemed necessary to support the analysis. The unit of analysis for all the research questions will be country, since I will be analyzing data that characterize a transition to renewable energy measured at a national level, for Chile and other countries. A description of each of the methods used in the analysis and its corresponding sources is presented below.

<u>Document review:</u> On the qualitative side I performed an exhaustive document review, and a set of in-depth interviews and site visits to several renewable energy generation plants across Chile. For the document review I studied governmental reports, environmental NGOs' documents, reports elaborated by international organizations, energy/electricity magazines, scientific publications, legislation documents and media articles.

<u>In-depth interviews:</u> The in-depth interviews were conducted in Chile (in June-August 2016) to key policy-makers and relevant actors that have participated in and witnessed the transition. I interviewed government officials from the Ministry of Energy and the Chilean Development Agency, financial sector executives, executives from the private sector working in renewable energy projects as well as from incumbent companies, experts from universities and consultant firms, environmental advocacy groups, congress people, representatives from the German Society for International Cooperation (GIZ) in Chile, and representatives from different regulatory agencies. The interviews were conducted in Santiago de Chile (capital city) and Concepción (second largest city). The average interview time was between 45 minutes to 1 hour. I conducted a total of 45 formal interviews (43 recorded, 2 non-recorded). I started with a selected list of interviewees that I put together based on online research and expert suggestions. This preliminary list was complemented with suggestions from the interviewees themselves following a snowball sampling approach. The interviewees were recruited through email and phone. Interview subjects were offered confidentiality but most of them choose to decline it, arguing that they had no problem in sharing their views and positions. In this manuscript though, I

chose to preserve quotes as anonymous to protect the identity of the interviewees. A complete list of all interviewees' positions (classified by categories) is attached in Appendix A. Additionally, interview protocols (questionnaires) are attached in Appendix B. It is worth mentioning that in addition to the 45 formal interviews I had approximately 20 informal conversations with other actors/observers of the transition, which included a couple of interviews with some experts from multilateral organizations working in Washington, DC, in the US.

<u>Site visits:</u> Within the same field trip, I complemented the analysis with a series of site visits to several renewable energy power plants located across Chile in the Northern, Central and Southern region. I did 5 formal visits to generation plants, including solar installments, wind farms, and run-of-river power plants. Locations are marked with blue squares in Figure 1. I also toured throughout the respective geographical zones where concentrations of solar installments and wind farms have emerged due to the great quality of natural resources available in the areas. Locations are circled with a red line in Figure 1. Pictures from the fieldtrip are attached in Appendix C.

<u>Quantitative analysis:</u> The qualitative analysis was complemented and contrasted with the exploration of quantitative energy and electricity data, as well as general macroeconomic figures form national and international indicators. This data was mostly retrieved from national institutions' websites (e.g. governmental and regulatory institutions) or international databases (e.g. the World Bank, Inter-American Development Bank).

Table 1.2 contains a summary of the proposed research questions and hypotheses, as well as the methods that were used for addressing them.

Table 1.2. Summary of research questions and hypotheses.

Research Questions	Hypotheses	Method/Data	Type of Analysis	Chapter
Overall Question (descriptive + explanatory): *Why has a transition process towards the use of renewable energy unfolded in Chile during the last decade? What does the empirical evidence from the Chilean case tell about how and why transition processes come about?*	With this question I attempt to describe the overall story of Chilean transition and to elucidate triggering motivations, as well as to assess whether available transition theories (the Multi Level Perspective framework in particular) is adequate for explaining (part of) the Chilean case.	Interviews, document review (national and international reports, and energy/electricity magazines), quantitative analysis of electricity and macroeconomic data, and site visits	Mixed methods	Ch. 2 & Ch. 5
Sub-Questions:				
Question 1: *What has been the **role of social movements and organizations** in opening up windows of opportunity for socio-technical change towards the use of renewable energy in Chile and why did they decide to engage in the transition process?*	**H1:** Civil society organizations have played a crucial role in the Chilean transition enabling socio-technical change to take place in the prevailing regime that was established in the Chilean electricity sector.	Interviews, media review, document review of NGOs' reports	Qualitative	Ch. 3
Question 2: *What has been the **role of the Chilean government** in the energy transition taking place in Chile and why has it acted in such ways? In particular, **how regulations have modified the structure of the electricity market** and in which ways this has the transition?*	**H2:** The Chilean government has played a significant role in the transition by envisioning energy policy objectives, by creating new institutions, and specially through the reshape of the electricity market via legislation reforms. The implementation of regulations has changed resulted in an evolution from a completely liberalized electricity market to one that involves increasingly more regulation.	Interviews, review of legislation documents, review of governmental reports, review of reports from international organizations, review of international journals and magazines, quantitative analysis of electricity data	Mixed methods	Ch. 4
Question 3: *What **challenges are ahead** for the Chilean energy transition? Based on obtained findings and theoretical analyzes, what **recommendations** might be useful for future **energy policy-making** in Chile?*	This question focuses on identifying the challenges that are ahead of the ongoing energy transition in Chile. I also expect to make policy recommendations based on the findings.	Interviews, review of governmental reports, review of reports from international organizations, review of reports from other countries	Qualitative	Ch. 6

1.4. Expected contributions and significance of the study

The objectives of this study are twofold: (1) it contributes to the national policy dialogue on how the energy transition has happened and what challenges and opportunities come ahead (as engaging in this conversation is aligned with my future professional interest), and also (2) to contribute to the theoretical understanding of how transitions to more environmentally responsible practices come about in the context of developing countries.

I expect to get a political product and an academic product. (1) The political product will include a description of the Chilean case that I expect is to be useful for Chilean policy-making in the energy and other sectors, as well as a set of recommendations for energy policy making in Chile. (2) The academic product will comprise a couple of publications that will attempt to both tell the Chilean story and to assess whether sustainability transitions theories are suitable for explaining the case, as well as to contribute with observations from the Chilean case that might be useful for understanding and replicating transitions in other developing countries.

I expect the audience of my dissertation to be mixed, composed by two main groups: (1) Chilean policy practitioners: Chilean policy-makers, policy analysts and advocacy groups, and (2) Academic researchers: transition researchers and others scholars working in theoretical studies of how transitions to sustainability come about in developing countries.

1.5. Plan for this research

The research study will be presented as follows. In Chapter 2, I will describe the events and figures that together comprise what I call the ongoing Chilean transition towards the use of renewable energy. At the end of this chapter, I will start analyzing the dynamics of the transition by characterizing the Chilean story in terms of the MLP.

In the following three chapters will elaborate on the dynamics of the Chilean transition, exploring two specific aspects of the transition in the subsequent two ones, and for then zooming out again to look at the great picture and overall transition dynamics in the following one.

In Chapter 3 I will explore how niches developed and how they were able to break-through taking advantage of the window of opportunity that opened up in the regime. I will explore in particular how certain social organizations —environmental NGOs and industry associations in particular— worked for opening up that window of opportunity for socio-technical change to occur in the prevailing regime.

In Chapter 4 I will look at the role that the government has had in the transition, as an enabler of the changes that have happened. I will explore the role that the government played in modifying the existent regime, especially through the creation of institutions and by passing regulations that modify the structure of the electricity market.

In Chapter 5 I will come back to discuss the overall dynamics of the Chilean transition in a more informed and deeper way, after reviewing the aspects discussed in chapters 3 and 4. In this chapter I will focus on a theoretical analysis of the transition and on the contribution that the particular Chilean case can make back to the theoretical study of transitions, particularly in developing countries' contexts.

In the following Chapter 6 I will look at the future and identify challenges for the further development of renewables in Chile. The purpose of this chapter is to make recommendations for policy-making that allows the transition to continue unfolding.

The study ends with a chapter that summarizes findings and state relevant conclusions (Chapter 7).

CHAPTER 2. THE ONGOING CHILEAN TRANSITION TO RENEWABLES: A DESCRIPTION OF THE GENERAL STORY

2.1. Introducing the chapter and defining the scope of the study

This chapter seeks to describe the general story of the transition towards the use of renewable energy that started to happen in Chile in the last decade, and begins the analysis of the underlying dynamics of the transition process. The chapter focuses on the descriptive part of the overall research question that guides this dissertation which is *Why has a transition process towards the use of renewable energy unfolded in Chile during the last decade?*, and begins the analysis on how events took place and what motivations have driven actors to take actions that enabled and unleashed the transition. The analysis of the transition dynamics will be resumed in Chapter 6, after the study of specific aspects of the transition is presented in subsequent Chapters 4 and 5.

This chapter tells the general story of the change towards the use of (non-conventional) renewable energy sources that the Chilean electricity mix has experienced since 2005 until the end of 2016. The transition that has taken place has resulted in an increase of the installed power generation capacity coming from NCREs from a negligible percentage to 17% of the mix in April 2017, and the percentage of electricity coming from renewables has grown as well reaching 15.7% of the mix in March 2017 (CNE, 2017). I focus the analysis of the Chilean electricity transition only on the development of wind, solar PV and small scale run-of-river power plants, since these are the NCRE technologies that have been mostly implemented in Chile and their story then reflects the Chilean transition's dynamics. Biomass generation was excluded because even when the sector has experienced some development in recent years, it has always been mostly associated to the pulp and paper industries and in that sense its development has not experienced much of a transition. I examine the development of renewables focusing on NCRE technologies[2], that is excluding large-scale

---

[2] The term non-conventional renewable energy sources (NCRE) was firstly introduced in 2005, with the Short Act 1. It is a term of high political sensitivity that basically excludes large-hydropower from the group of renewable energy technologies. The introduction of the term was pushed by environmental advocacy organizations, and was generally accepted by the current government as it makes allusion to renewables other than those that had been traditionally

hydropower (>20MW), as the transition that has taken place in Chile has not involved this technology, which is considered conventional in the country and has been long used for electricity generation.

The Chilean transition was not one of envisioned transition management neither it was at the beginning motivated by strong sustainability convictions. Rather, the Chilean case was a transition that started mainly driven by energy security needs and the pursuit of economic efficiency. The strategy adopted by the government followed mainly a market failure approach, and then the transition process was not driven by a vision of favoring clean energy technologies at any price, but the original intention just aimed to open NCRE sources space to compete with incumbents in fair conditions. In fact, Chile was among the first countries where wind farms and solar PV technologies were introduced without incentives that supported their deployment, and yet they were able to compete successfully with conventional energy technologies. Environmental sustainability values were considered relevant from the beginning, but not as relevant as the aforementioned energy security and cost-efficiency objectives, though as the transition moved forward, sustainability gained more and more prominence as a core value embraced by the country.

Importantly, the present chapter has a particularly important value in itself as the story of the Chilean transition has not been formally documented. This then constitutes the first attempt for putting together this story and trying to make sense of its underlying dynamics.

The chapter starts providing some background information on Chile and its electricity systems. Then I present the methods that were used for developing the research contained in the chapter, which include mainly qualitative techniques that were complemented with quantitative data. I start presenting the facts of the transition providing a timeline of the most important events that have characterized the Chilean case and a description of the transition in quantitative facts. After that, I start describing the transition by linking events and trying to explain how and why they are connected and

---

developed in Chile (“conventionals”), which included large-scale hydropower. The debate over the term is still big in Chile; those that still want to continue building large-scale hydropower generation plants defend them arguing for their low emissions, while environmental advocacy groups think that the NCRE term is useful as dams are denounced to have huge environmental impacts. In the recent policy document *Energy 2050* that will be analyzed later, the government did not mention the term and started setting targets for renewables in general, instead of only for NCRE sources. This dissertation leaves that debate aside, focusing only on NCRE sources, as that is the sector that has experienced mayor development in the last decade.

lead to one another up until the current stage. By the end of the chapter I start characterizing the Chilean transition in terms of sustainability transition theories, namely the Multi-Level Perspective (MLP). I use the MLP as a basis for start interpreting the transition's dynamics. This analysis will then be resumed in Chapter 6, after I analyze deeper specific aspects that are key for understanding the overall dynamics in Chapters 4 and 5.

2.2. Background information on Chile and its electricity system

This section provides a general description of the Chilean context from a macroeconomic and political point of view, as well as the energy and electricity context in which the transition takes place.

2.2.1. Chile: broader context and macroeconomic overview

Chile is a developing country located in the Southern Cone of Latin America. It has a population of 18 million inhabitants, with 7 million people living in the capital Santiago de Chile (Wikipedia, 2016). The country has the highest Human Development Index (HDI) in Latin America (UNDP, 2015) and it leads the region also in competitiveness, income per capita, globalization, state of peace, and economic freedom. It is a nation with strong institutions and a (relatively) well established rule of law. However, the country also has the highest inequality Gini-coefficient among the OECD countries (OECD, 2016).

Figure 2.1. Chile's geographical location.

The economy of the Chile is considered strong under developing countries' standards, although it currently relies heavily on natural resources extraction. It is a relatively small economy, considered strongly integrated into world markets. Chile is mainly a commodity-exporting country. Its major export is copper, Chile being the major exporter in the world. Other major exports are agricultural (fruit), fishing (salmon), forestry products (pulp), wines and ores. Chile's major imports are crude and refined oil, coal, gas and lubricants, and machinery (note the predominance of the energy sector). Its predominant import destinations are the US and the European Union. Investment reports from the US and Canada describe Chile as attractive for foreign investment, referred to as “a great place to do business” by investors from the US, Europe, and China, thanks to its well-functioning capital markets and business-friendly culture (US ITA, 2015; MaRS, 2015). Chile has signed Free-Trade Agreements (FTAs) with a whole network of countries, including the US (2003), China (2005) and the European Union (2002), (Wikipedia, 2016b).

Figure 2.2 shows the evolution of Chile’s real GDP, which reflects its constant growing tendency that has been maintained over the last decade. Figure 2.3 depicts Chile’s inflation rate, as the annual percentage change in consumer prices, which also reflects moderate changes except for the years of the US-European financial crisis in 2008-2009. Figure 2.4 shows the trade balance per year, evidencing Chile’s dependency on imports. Figure 2.5 shows the evolution of the currency exchange value for the last decade. Figure 2.6 was included to depict the health of the Chilean economy. It shows the debt services of the country, along with its revenues and expenditures, evidencing the debt/lending capacity of the Chilean economy. Figure 2.7. shows the evolution of final energy consumption index and GDP, illustrating the interdependence between both factors that characterizes developing economies.

The Chilean transition case has to be anchored on a neoliberal context. Chile is a famous case where the neoliberal ideology was imposed in the 80s, during the dictatorship period of Pinochet. In the 90s with the return to democracy, many opposition governments have tried to implement socialist reforms with success to some extent, but the general neoliberal framework has prevailed. In part, I think, it is due to the 1980 constitutional framework imposed during the dictatorship that remains ruling until today, which makes passing radical changes very challenging and unlikely, and also due to the political coalitions that have emerged in the context of that political framework. Moreover, in recent years, major political corruption scandals have been exposed to the public, exhibiting links between important political representatives, from both the executive branch and congress, and major firm owners and representatives, which constitutes evidence of the interest of the elite on maintaining the neoliberal ideology in the country.

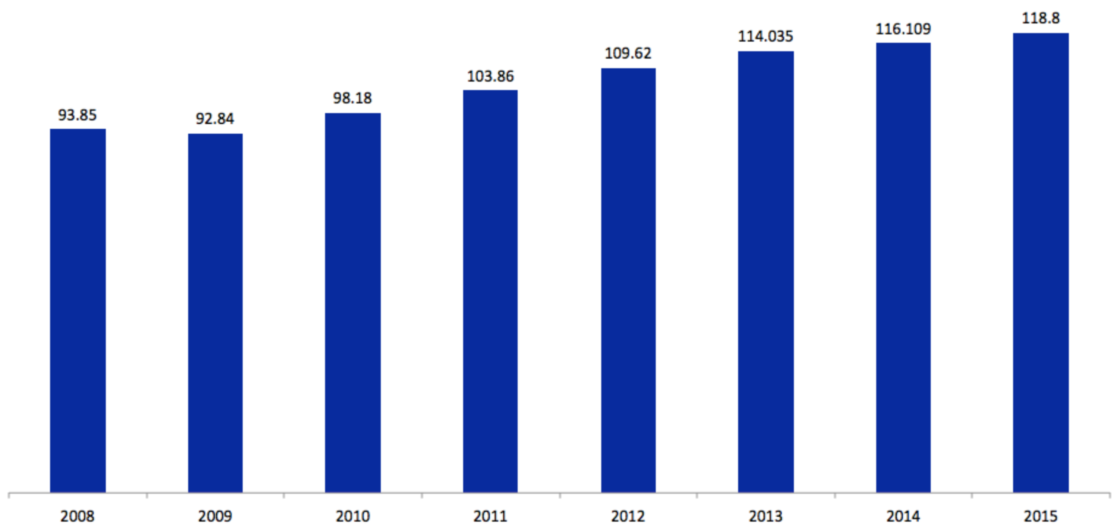


Figure 2.2. Real GDP seasonally adjusted (base year 2008) in billions of Chilean pesos. Data source: Chilean Central Bank.

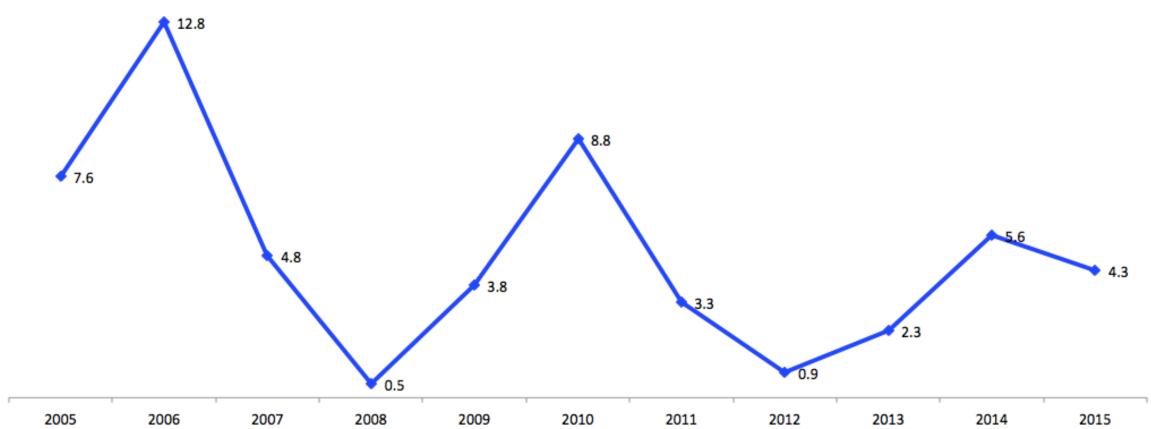


Figure 2.3. Inflation rate, annual percentage change in consumer prices. Data source: International Monetary Fund.

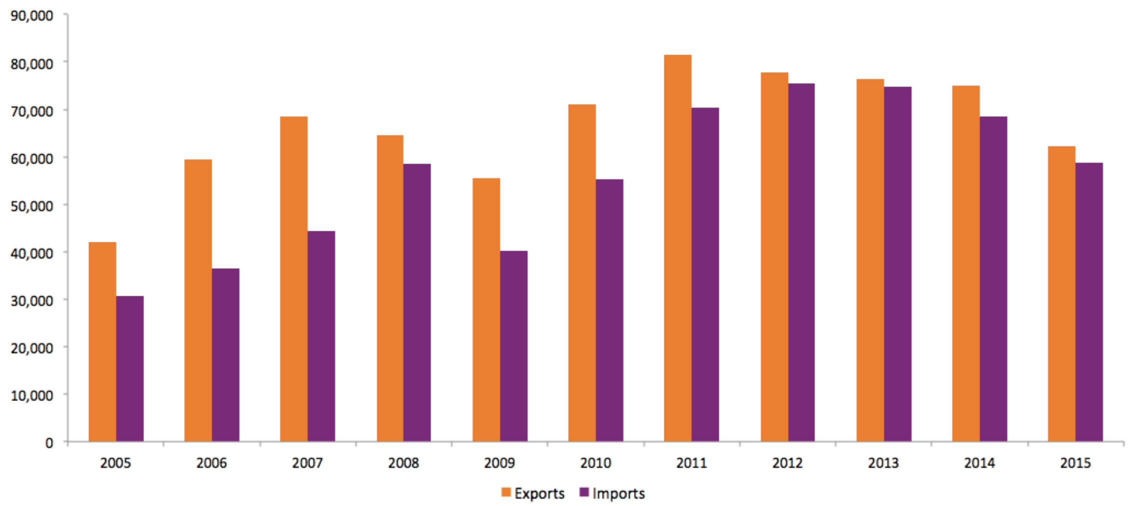


Figure 2.4. Trade balance per year, exports and imports in billions of Chilean pesos. Data source: Chilean Central Bank.

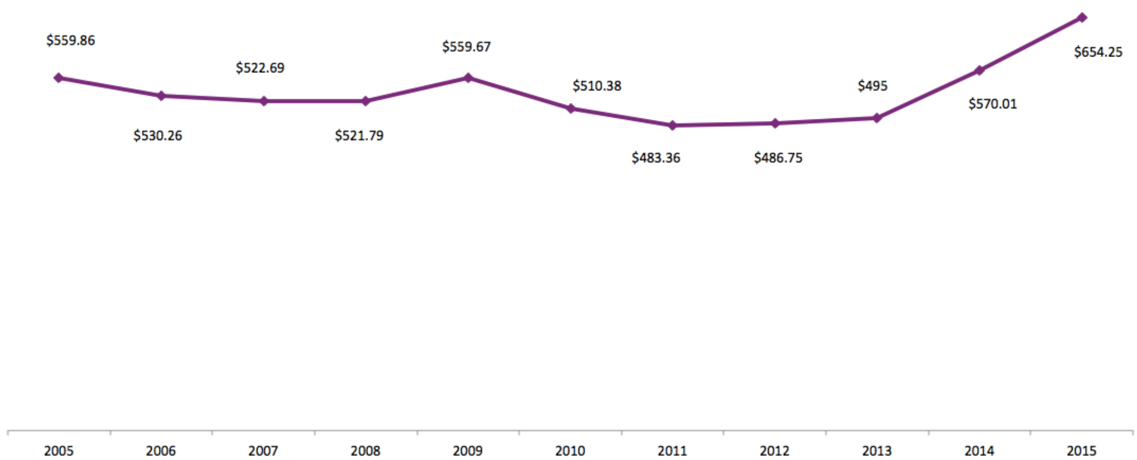


Figure 2.5. Evolution of currency exchange value: 1 USD in Chilean pesos. Data source: Chilean Central Bank.

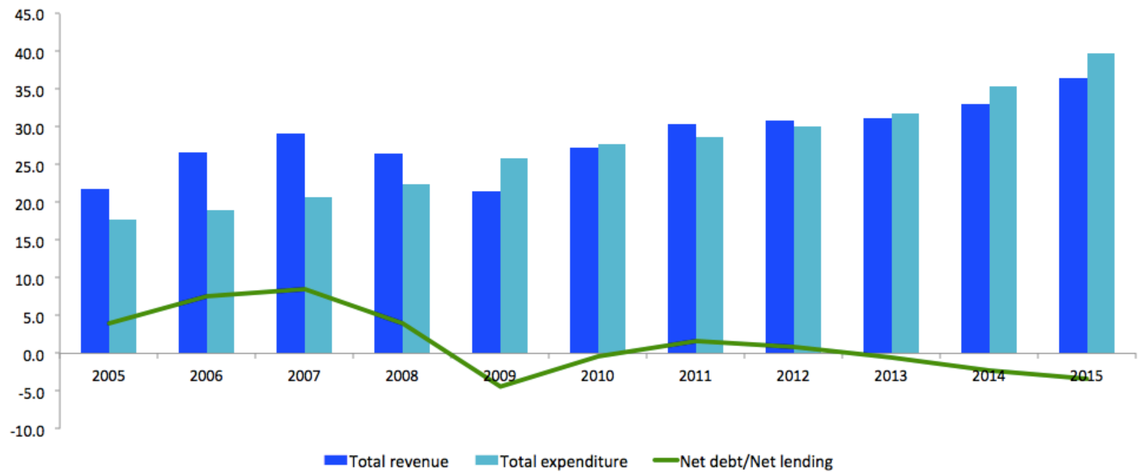


Figure 2.6. Total revenue, total expenditure and net debt in millions of Chilean Pesos. Data source: Chilean Central Bank.

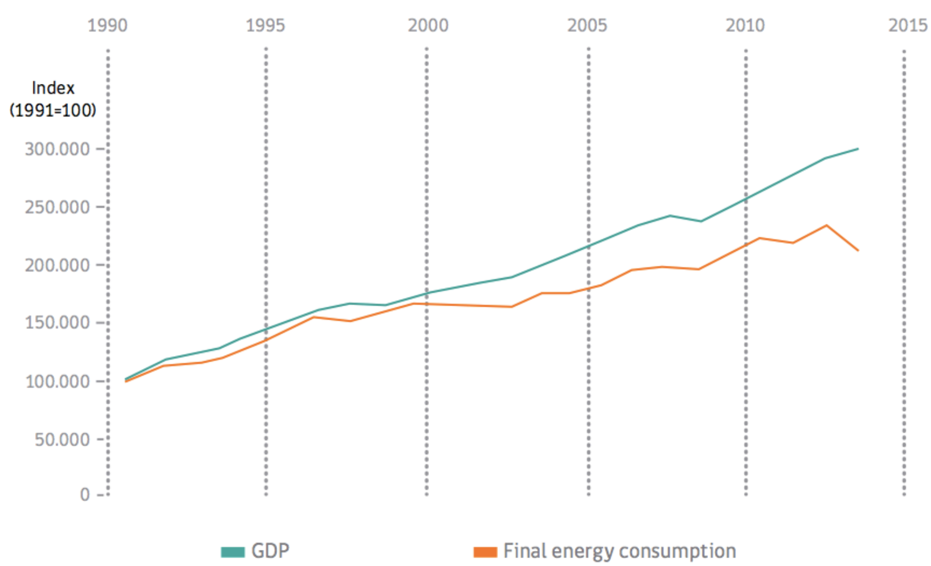


Figure 2.7. Final energy consumption index and GDP (base 1991=100). Source: World Bank data, graph published by Ministry of Energy (2015).

2.2.2. Chilean electricity system overview

Chile has a privatized electricity market. The Chilean electricity market underwent liberalization starting in 1982, with the approval of the General Electricity Services Law that rules until today (in Spanish *Ley General de Servicios Eléctricos*). This law separated the provision of electricity into the three segments of generation, transmission and distribution. These markets operate separately and are all financed by private investment, with intense competition often acting as the driver of decision-making. The generation sector operates as a deregulated competitive market with the private sector being free to invest in capacity —perhaps it is relevant to add that Chile does not count so far with a land-use policy that regulates electricity infrastructure development—. In that sense, any generation company is allowed to install a generation plant wherever they deem appropriate if it fulfills all the required permits, being environmental approval (obtainment of the Environmental Qualification Resolution, in Spanish *Resolución de Calificación Ambiental*, RCA) among the most strict and long steps of the process. Connection to the transmission network is governed by the principle of open access, that is, generators are allowed by law to connect to any substation that counts with enough space, or to expand the necessary facilities and/or lines to do so. Access to transmission lines is not guaranteed though, and depends on the physical capacities of the corresponding line and on the dispatch management process.

The transmission and distribution segments of the market are also privatized, but subject to a regulatory framework that affects expansion decisions and requirements, sets tariffs for core segments of the system, and ensures third-party access. Regarding commercialization, consumers with less than 0.5MW of installed capacity must buy from a distribution company at a regulated price, those that consume between 0.5 and 5 MW may decide whether to buy at a regulated price or to negotiate a contract with a generator, and users with a more than 5MW of installed capacity buy power at prices set by bilateral negotiation or private tender. The main driver of the Chilean energy market is the growing energy demand that has been characterized so far with high annual growth rates.

Electricity systems' infrastructure

Chile's electricity infrastructure is divided into four distinct (non-connected) transmission grids, each one providing power to a specific geographic location. These systems are not integrated due to the long geographical distances between them, but Chile is currently building the infrastructure for connecting the two main ones —the SIC and SING to be described below— which is to be ready approximately in 2018-2019. More details about the transmission interconnection will be presented and discussed later on this and other chapters.

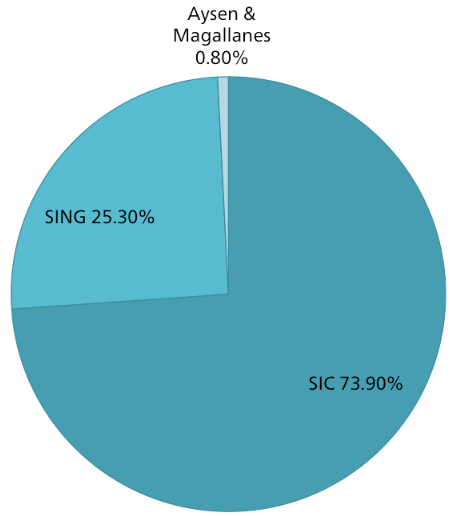


Figure 2.8. Electricity generation share by electricity system. Data source: Ministerio de Energía (2015).

According to data from the Chilean Government:

- The Central Interconnected System (in Spanish *Sistema Interconectado Central*, SIC) provides power to the vast majority of Chile's citizens, including the capital city of Santiago. In 2014, the SIC generated 73.9% of Chile's energy.
- The Norte Grande Interconnected System (in Spanish *Sistema Interconectado del Norte Grande*, SING) provides electricity to Chile's largest energy consumer —the mining industry— is located in the North of the country. In 2014, the SING, produced over one-fourth of the country's electricity.
- A combination of two electricity systems provides electricity to Chile's sparsely populated southern districts in Aysen and Magallanes. Together these grids only account for 0.8% of the nation's electricity production. Notably, while the southern part of the country produces very little electricity, it is the location of many high-potential renewable energy sites, particularly for hydropower and wind development.

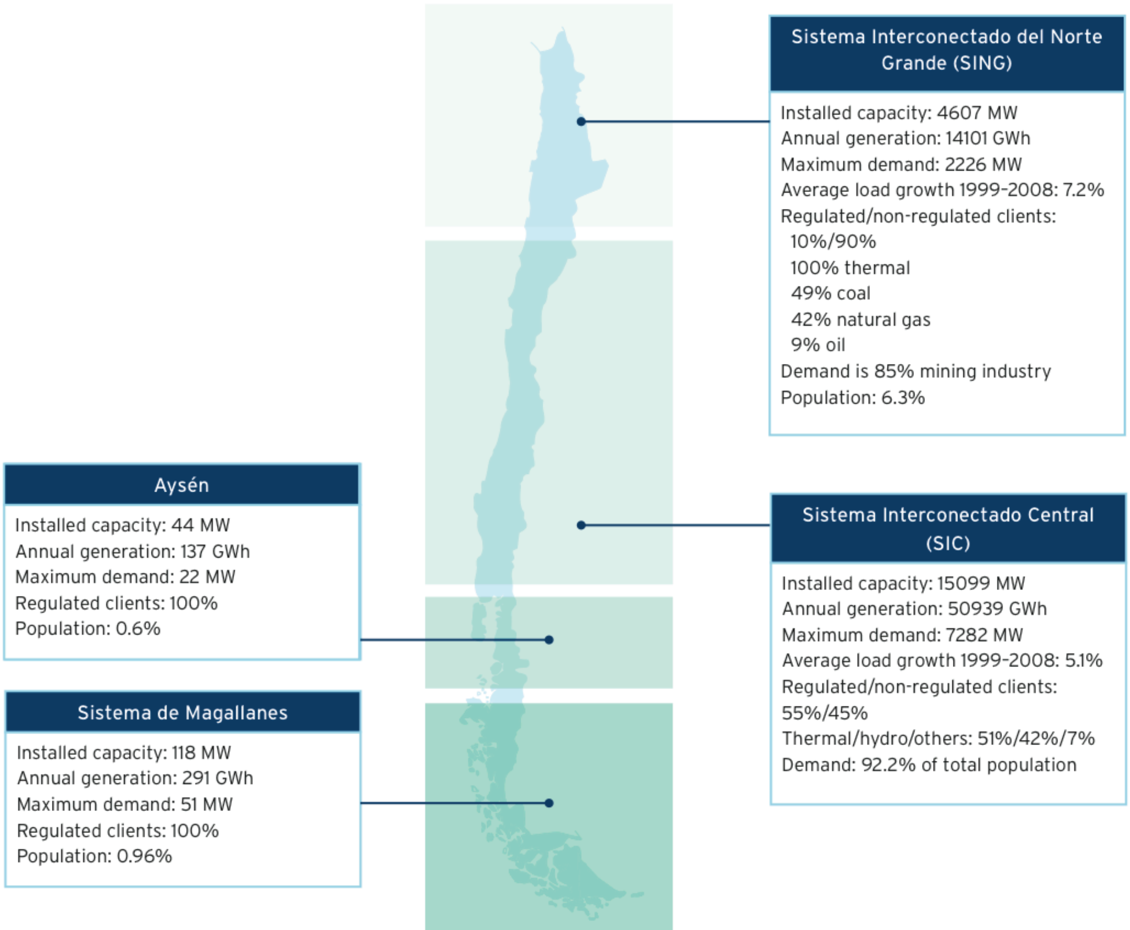


Figure 2.9. Current Chilean Electricity Systems. Source: Figure retrieved from MaRS (2015).

Operation of the electricity market

The 1982 Electricity law introduced the concept of two categories of consumers: regulated and non-regulated. Regulated customers buy from local distribution companies and pay regular distribution prices plus a node price of energy, based on the marginal cost of energy, a capacity charge and a transmission charge. Non-regulated customers (called “free clients”) have to have a maximum demand above 2 MW and are free to negotiate directly with generators for power supply. Chile has no competition/choice in electricity commercialization for small consumers at home or private businesses, and Chile does not have demand-side management programs for regulated customers either.

Since 2008, generators of electricity can participate in public tenders under long-term contracts to sell power to distribution companies at a fixed price (regulated costumers). At the same time, a spot market exists for power transfers not subject to existing Power Purchase Agreements (PPAs) (unregulated costumers) and electricity companies, though unregulated, are required to organize their operations through the Load Economic Dispatch Centers (in Spanish *Centros de Despacho Económico de Carga*, CDECs), an (ideally) independent entity that ensures that the grid is efficient and supply is secure. Generators operating in each regional power market declare their availability and marginal operating costs every hour to the CDECs to set the spot price. On the other hand, regulated prices for electricity generated are determined based on expected spot prices over a four-year period.

Whether through long-term agreements or the spot market, most power producers sell their electricity into the wholesale electricity market. Utility companies buy power from the wholesale market and supply it to electricity customers. Chilean utilities are often large companies that have a geographic monopoly through a concession. The wholesale electricity market is privately operated by the CDECs, an independent entity formed whose directory was traditionally composed of all actors operating in the system. In practice, the wholesale market has been traditionally controlled by the large companies that operate as a virtual monopoly in Chile, as a result of geography and the cost of building transmission grids (Bloomberg New Energy Finance, 2012). Indeed, the structure of the electricity market up-to-date is highly concentrated with 65% of electricity generation controlled by three major companies (33% Endesa/Enel, 16% AES Gener, 16% Colbun, 35% Others) (Vagliasindi and Besant-Jones, 2009). Importantly, a law passed last July changes the structure of the CDECs onto a new coordination entity that is to be truly independent.

In addition to the above, there some large mining companies in Northern Chile have also built their own power systems in the last decade, since either connecting their operations to a far-away electricity grid or operating diesel generators became increasingly cost prohibitive (US ITA, 2013). Many of these firms have turned to renewable energy —either solar or small wind energy mostly— to provide their power needs, being among the first clients of the pioneer NCREs installments.

Chile's regulatory framework has weaknesses that have been highlighted by drought events and unexpected supply restrictions. Fragilities in the regulatory framework combined with delays in important electricity infrastructure projects led to an increasing concern about the security of Chile's energy mix. As a result, the Electricity Act has been amended several times in recent years and the government has made some attempts for defining an energy policy strategy that replaces the old approach that relied completely on a fully liberalized electricity market. In 2015, the Chilean Government launched its new Energy Policy that defines energy policy goals for 2050. In particular, this policy establishes the goal of achieving 75% of the Chilean energy coming from renewable energy sources by 2050. The evolution of the electricity market's structure will be deeply explored in Chapter 5.

2.2.3. Main energy institutions (Olivares et al., 2013)

Currently, the governmental branch in charge of the energy sector is the Ministry of Energy, which was created in 2010. Previously, the energy sector was dependent on the Ministry of Mining until 2007, when the National Energy Commission transitioned to be a separated entity. The ministry's functions are developing and coordinating plans, policies and standards for the proper functioning and development of the sector, to ensure their compliance, and to advise the government on all energy-related matters.

The ministry's regulatory organization is the National Energy Commission (in Spanish *Comisión Nacional de Energía*, CNE). It is a technical entity in charge of analyzing and regulating prices and tariffs for the energy sector, setting technical and quality standards for the functioning and operation of energy facilities, and monitoring and forecasting current and expected performances of the energy sector, among other activities. In particular, the CNE performs an indicative planning of investment in generation and transmission, draws up regulations and rules, and calculates tariffs for regulated customers. The CNE may also determine the development of specific electricity projects, such as transmission projects, that are not being pursued by the private sector. The financing of these projects is done through a standard bidding process in which private companies are free to participate.

There is also the Superintendence of Electricity and Fuels (in Spanish *Superintendencia de Electricidad y Combustibles*, SEC), which is the public agency in charge of overseeing the Chilean energy market, including the proper operation of electricity, gas and liquid fuels in terms of safety, quality and price. Among its key faculties and duties are monitoring compliance with legal provisions, preparing regulations and rules, granting provisional licenses to power plants, electricity substations and transmission and distribution lines.

There is also the CDECs that where introduced in the previous section, which are private entities responsible for coordinating the operation of the electricity system. Their main responsibilities are associated with preserving global security and ensuring the cheapest operation possible for the entire electricity system facilities. Also, they must ensure open access to transmission systems (payments for transmission, bidding expansion projects for main transmission) and determine the marginal costs of energy and economic transfers among CDEC members.

There is also an Experts Panel of the General Law of Electricity Services, which is an entity in charge of solving through binding ruling any disagreements or conflict arising from the application of the electricity legislation, as well as any other disputes that companies of the electricity sector agree to submit to the panel's scrutiny.

In Chapter 5 I will analyze more deeply how the main institutions in the sector have evolved across the last decade.

2.2.4. Indigenous energy resources and renewable energy potential

Chile has limited fossil energy resources (oil, coal and natural gas). This is why today almost 60% of Chile's primary energy is imported. Chile's energy imports come from all over the world, which puts the country's economic growth at the mercy of global energy markets to meet its increasingly growing demand (Yapp, 2012), and leaves it vulnerable to geopolitical issues.

<u>Renewable energy potential</u>

In contrast to its lack of fossil fuel reserves, Chile counts with a significant clean energy potential. The most promising NCRE sources are wind, solar, geothermal and hydropower.

Chile is home to one of the world's largest solar resources; the Atacama Desert in the North which receives among the world's highest potentials of sunlight daily. A study published in 2014 estimated the generating potential of northern Chile in 1,640GW of photovoltaic solar power and 550GW in terms of concentrated solar power (Santana, 2014).

In terms of wind energy, Chile's potential has been estimated in 40,000 MW leaving aside the Patagonia region (Ibid.). The greatest potentials though, are precisely located in Southern Chile in the remote Patagonia region, but for now the country does not have a transmission network for carrying that energy to the more populated areas in the center or northern parts of the country where major urban settlements and production centers are located. Plus, the idea of developing generation and transmission projects in the Patagonia region is controversial and rises tremendous civil opposition.

Chile has also an astounding 10% of the world's active volcanoes, providing an abundant potential for geothermal energy that has been estimated in 16GW (over a 50 year period), yet to date no geothermal projects have been completed in Chile. In 2015, the first geothermal energy project started to be built as a joint venture from the state owned company National Petroleum Company (in Spanish *Empresa Nacional del Petróleo*, ENAP) and one of the three major private electricity generation companies in the country (Endesa/Enel).

Regarding its hydropower potential, Chile's total is estimated in 12 GW without considering the southern Patagonia region. Today, the country only produces roughly 5 GW of large-scale and small-scale hydropower, leaving significant room for growth. Major hydroelectric projects have faced important opposition in Chile though, on environmental, political and economic grounds. Projects in the Chilean Patagonia in particular, which is a region that offers huge hydropower potential, have faced massive opposition from local and international advocates seeking to protect this treasured local environment. These are areas of extreme environmental sensitivity and several hydropower projects have been stalled or cancelled due to environmental concerns, including the *HidroAysén* project that proposed to build four major dams in the Patagonia region equivalent to a total of 2,750 MW of installed capacity and a 2000km transmission line. Indeed, one poll found the *HidroAysén* proposal was so unpopular that 74% of Chilean citizens opposed the project on environmental grounds (Yapp, 2012), and in May 2011 30,000 demonstrators protested against the dams in Santiago and all across the country.

Beyond environmental, political and economic concerns, an additional factor that might affect the future of hydroelectric power in Chile is climate change (Woodhouse, 2011). Indeed, Chile is affected by three water climate change concerns: the reduction of rainfall in south-central Chile; the accumulation of less snow in mountains which correlates to less glacier melting; and the increased frequency of La Nina/El Nino ocean conditions that reduce the amount of water supply. It is projected that in the next forty years there will be a change in temperature and rainfall patterns; temperature will increase from 1°C to 1.5°C, yet rainfall will decrease by 10-15% (Painter, 2009).

In terms of biomass, Chile also has significant potential (though only very rough estimations are available). Today, biomass energy is mainly generated as a co-production from industrial waste from the pulp and paper industries. In fact, according to the USDA Foreign Agricultural Service (US ITA, 2013), Chile's forest industry has become so cost-efficient at converting its waste to electricity that it abandoned efforts to convert it to second-generation biofuels. There is also biomass generating potential associated to the management of forests, both plantations and native, as well as the processing of harvesting residues.

Generating biogas from the agroindustry residuals, landfills and sewage plants is another available option in Chile, though there are only a couple plants operating. With regard to biofuels, there is no much interest in Chile due to its limited area and agricultural resources, but anyway there are currently some research initiatives funded by governmental and private companies that focuses in the potential production of biodiesel from algae.

In addition to the above, Chile counts with 6,435 kilometers of coastline that might represent a huge resource once marine and ocean technologies for generating electricity are more developed and mature.

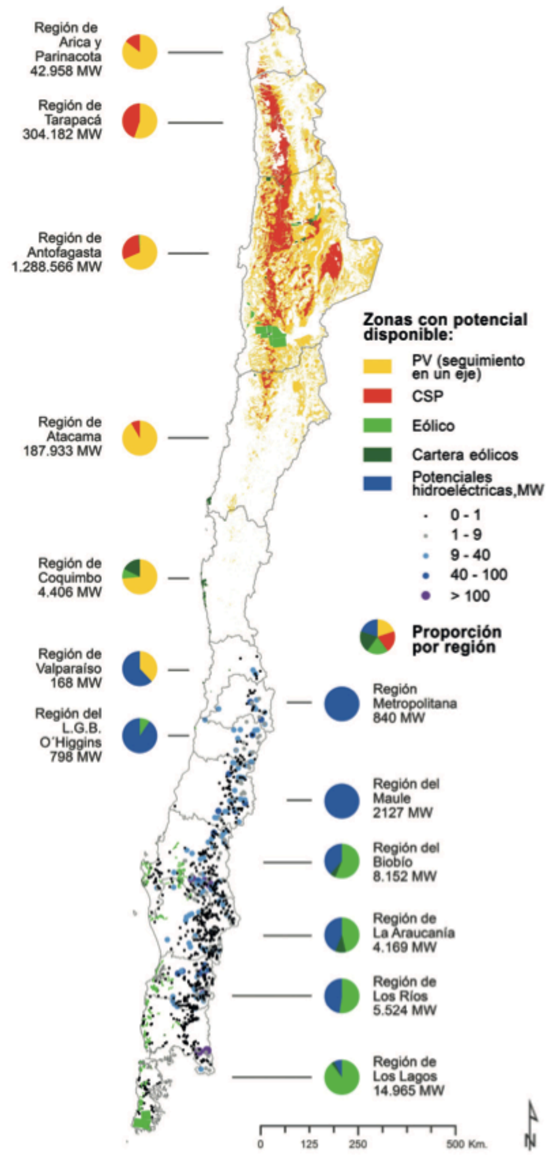


Figure 2.10. Chile's solar, wind and hydropower potential without superposition. Source: Santana (2014) .

2.3. The Chilean energy transition in quantitative facts

In the last decade Chile started experiencing a shift on its energy mix towards the use of renewable energy. The following quantitative figures of the electricity generation sector allow to track back the shift and to start telling the story of the transition.

In early 2005 the amount of electricity generated coming from non-conventional renewables was practically negligible. That situation changed over the years and recently the government just announced that by April 2017 the country has reached 17% of its installed capacity of 22,841 MW in NCRE sources equivalent to 3,795 MW, with 7% coming from solar PV, 6% wind, 2% small hydro, and 2% biomass (CNE, 2017), as shown in Figure 2.11. Moreover, current goals set a minimum of 20% of the electricity generation mix by 2025 that is expected to be reached before 2020. There are also long-term goals for reaching a 50% of the generated electricity coming from renewables (conventional hydro included) by 2035 and 75% by 2050 (Ministry of Energy, 2015).

Figure 2.12 and 2.13 depict the evolution of the installed power generation capacity from 2005 onwards. The graphs show how wind farms begin to appear mildly around 2009, though they mostly develop after 2011, and how solar energy (mostly photovoltaic) starts to develop in 2014. Small run-of-river plants started to be developed around 2005 and though their development increases across the years, they never experienced a boom like the one that wind and solar energy experienced in 2014 and 2015. Biomass already appears with a small share of the total installed capacity in 2005 and develops more over the years, but its current share is still small too.

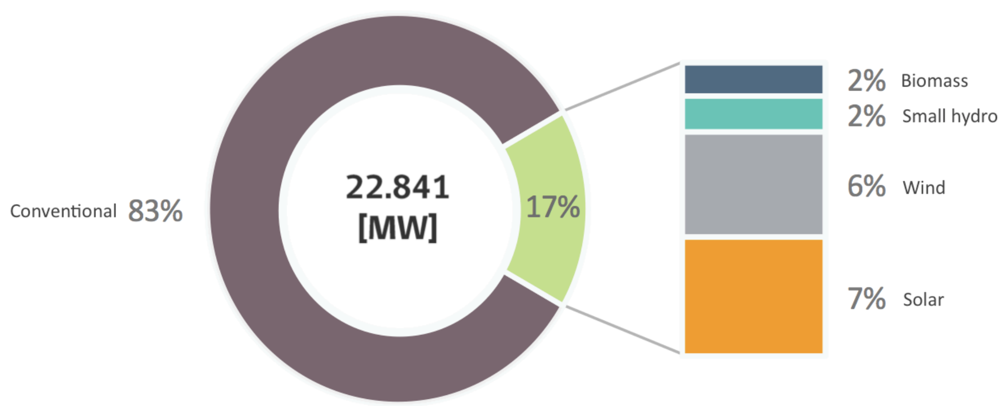


Figure 2.11. Current installed power generation capacity in Chile coming from NCRE sources by April 2017. Source: CNE (2017).

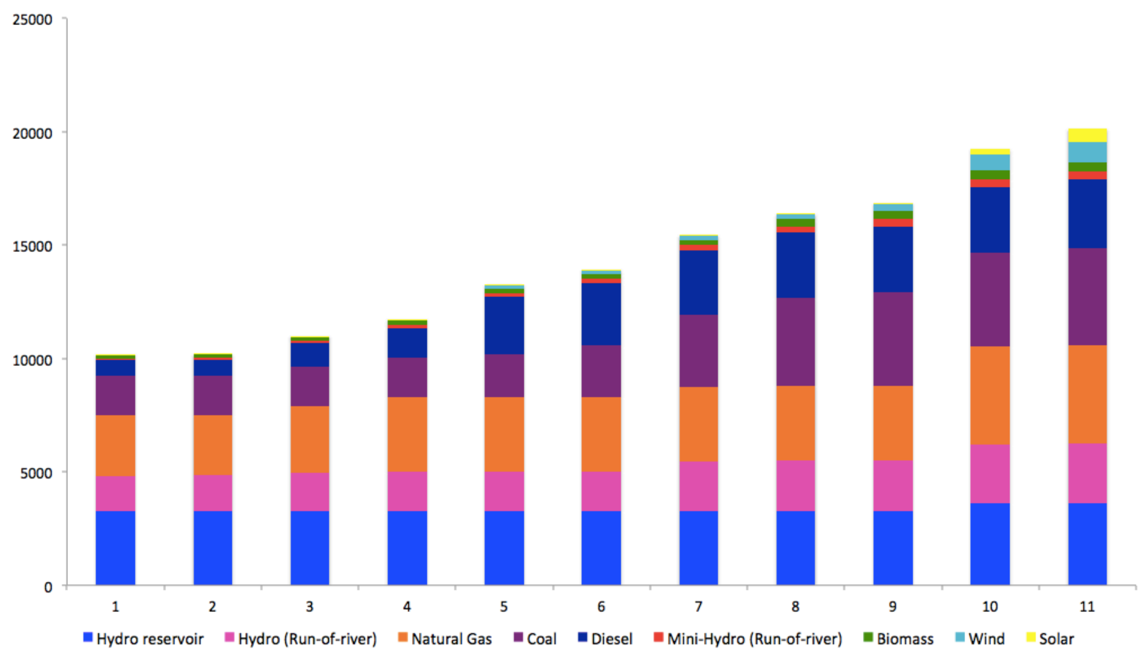


Figure 2.12. Evolution of the installed power generation capacity in Chile by year and by technology in MW. Data retrieved from CDEC SING and CDEC SIC.

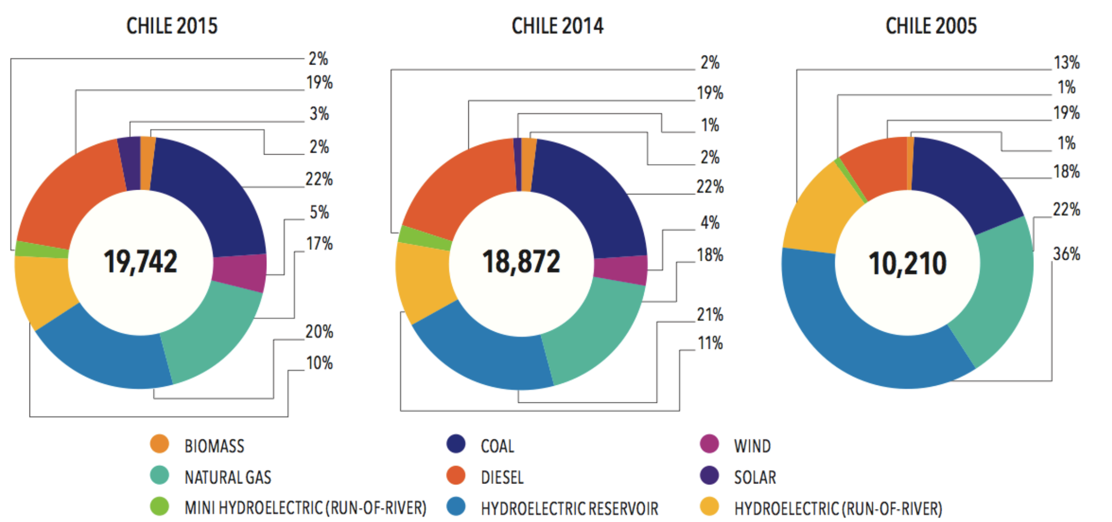


Figure 2.13. Total domestic installed power generation capacity in Chile by technology in MW. Source: CNE (2015), data retrieved from CNE, CDEC SING and CDEC SIC.

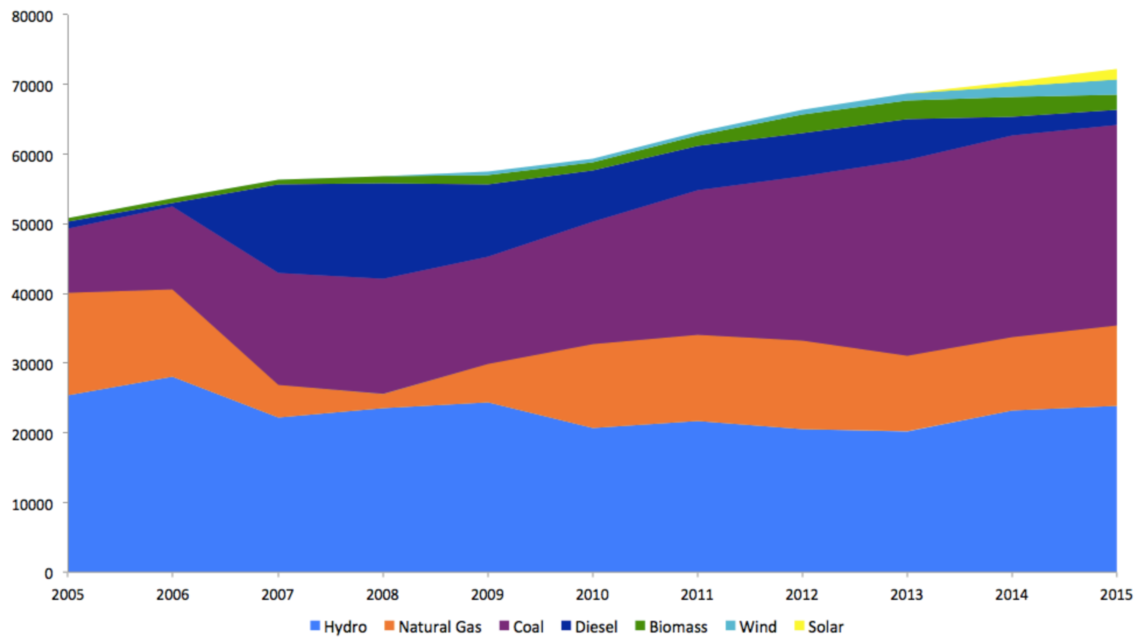


Figure 2.14. Evolution of domestic gross power generation in Chile by technology in GWh. Data retrieved from Ministry of Energy (2012), Ibid. (2015).

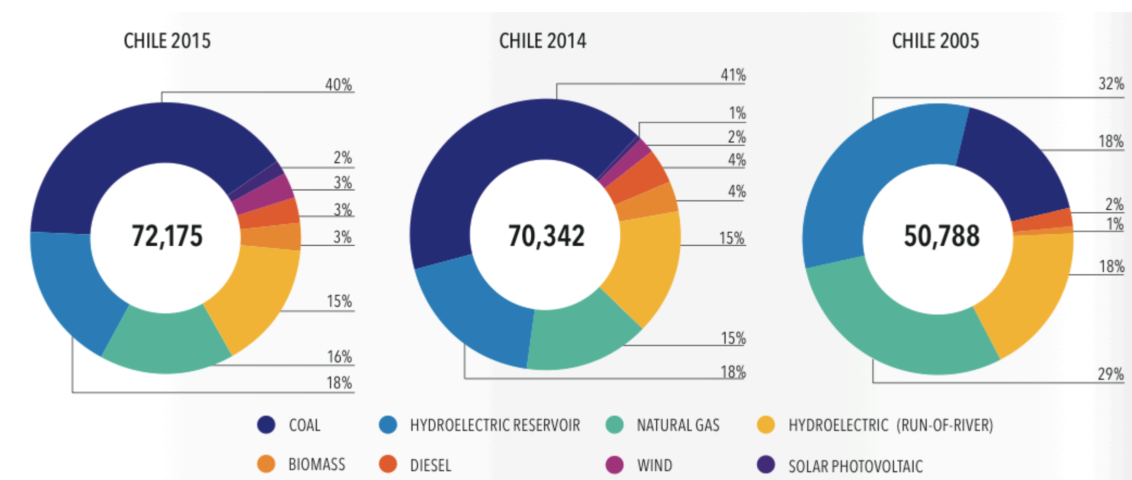


Figure 2.15. Total domestic gross power generation by type of technology in GWh. Source: CNE (2015), data retrieved from CNE, CDEC SING and CDEC SIC.

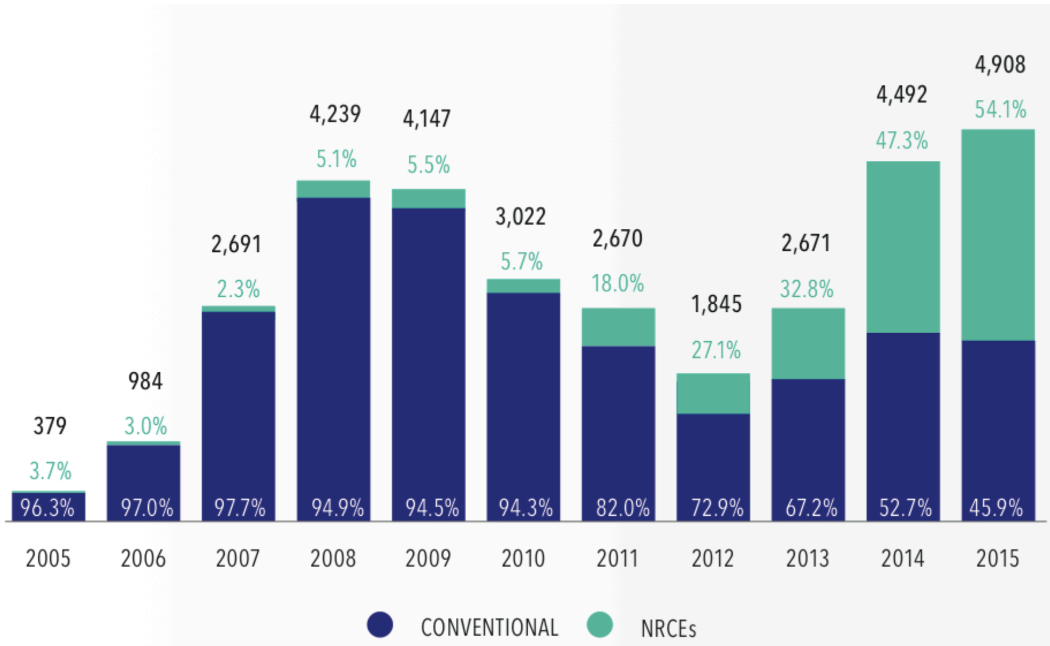


Figure 2.16. Expected operating entrance year evolution of the electricity generation projects under construction 2005-2015 in MW. Source: CNE (2015).

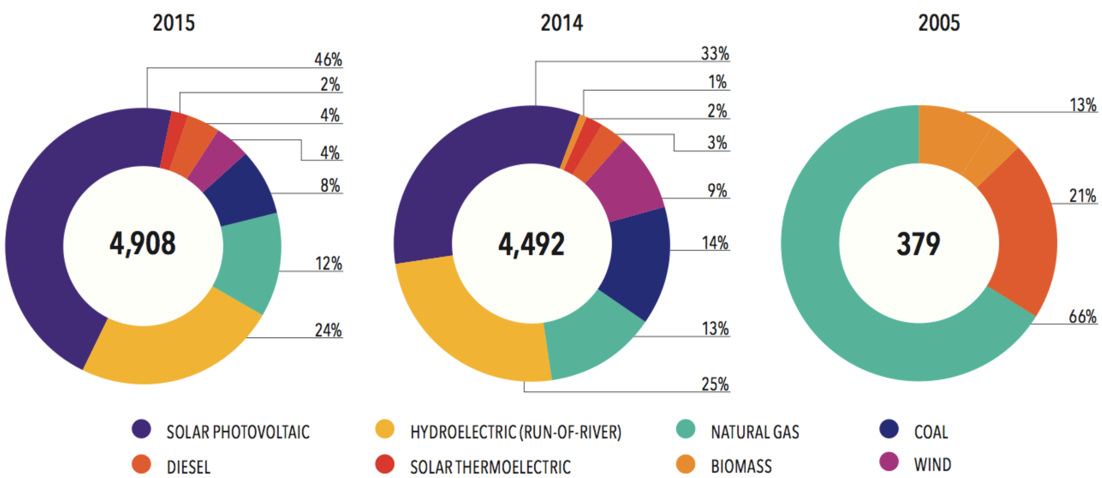


Figure 2.17. Total of power generation projects under construction per technology in MW. Source: CNE (2015).

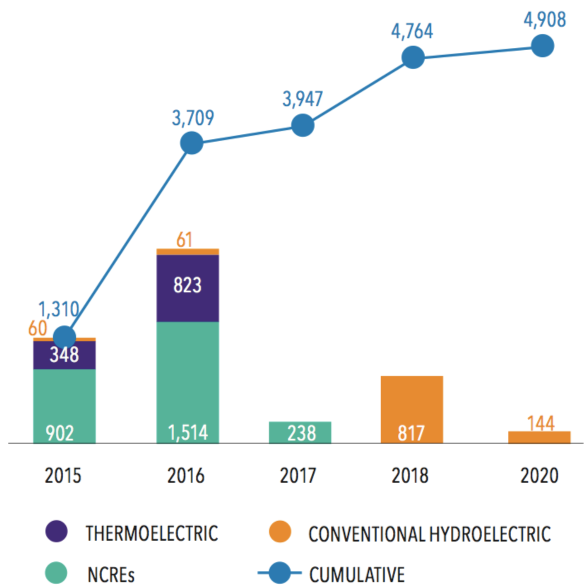


Figure 2.18. Forecast of power generation projects under construction as per date of operation startup in MW. Source: CNE (2015).

Figures 2.16, 2.17 and 2.18 indicate electricity generation projects under construction and how those numbers evolved over time. Figure 2.16 shows the impressive shift from conventional energy technologies to NCREs starts to become stronger after 2011, and Figure 2.17 opens up the specific number for current years. Figure 2.18 allows us to look a little into the future showing us what types of projects will start operating in incoming years. For understanding this figure it is especially important to take into consideration the amount of time that projects from different technologies need to be developed. Thermoelectric projects that take longer periods of time appear not being developed any more (as there are no scheduled projects after 2016), while NCRE projects that take less time to be developed (a couple of years usually or even less) are probably not appearing yet in the graph for years after 2017.

Figure 2.19 shows the evolution of electricity generation projects that obtained environmental approval RCA across the last decade, and the type of energy source they were using. The graph also shows the investment associated to each type of projects. Importantly, these figures are approximated and correspond to the quantities that were declared by developers to the Ministry of the Environment for getting approval of the environmental resolutions associated to the projects, and not all of them were finally developed and some are still on hold.

Figure 2.20 is included as an example of how the entrance of NCREs impacted the Chilean electricity generation market. Electricity prices were among the highest in Latin America during the years of the energy crisis that peaked by the end of the last decade (US ITA, 2013), but they have started to drop significantly as the entrance of new NCRE actors to the generation market has created more competition, as the government and experts have declared (Finat, 2015). Figure 2.20 in particular shows the price offered in electric power tenders held by the government have dropped over the years. Moreover, in the last public tender held in July 2016, nominal prices dropped even more reaching 47.6 US$/MWh (Diario Estrategia, 2016).

Why did this change happen and what have been the evolving dynamics of that change? The next two section describe the events that I have identified as the most relevant in the Chilean electricity transition. After that, the following section starts theorizing on the underlying dynamics of the change.

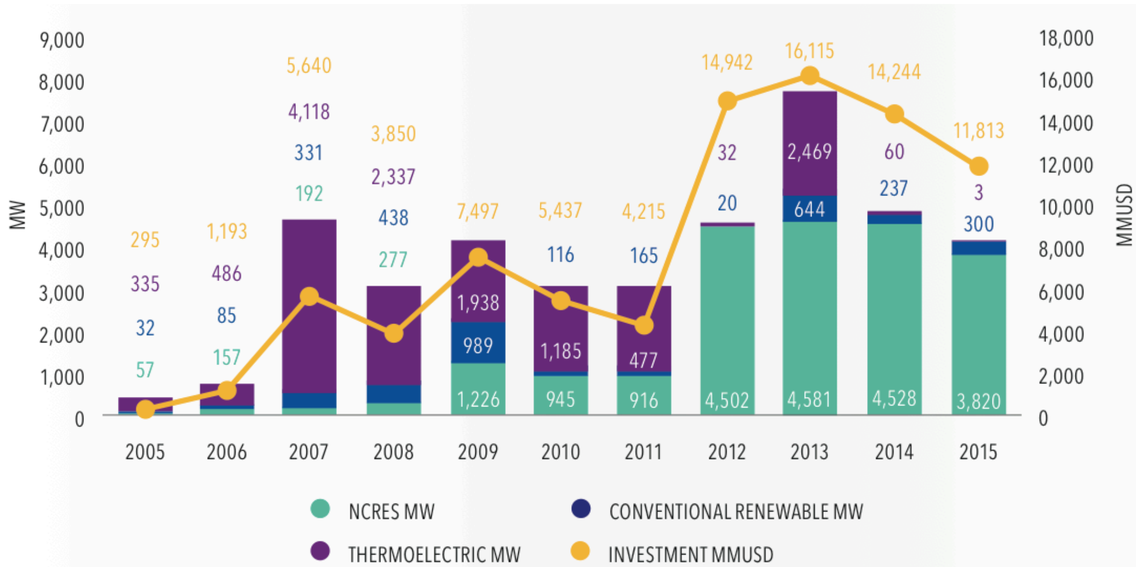


Figure 2.19. Evolution of RCA approved generation projects in MW and MMUSD. Source: CNE (2015), data source *Servicio de Evaluación de Impacto Ambiental* (SEIA).

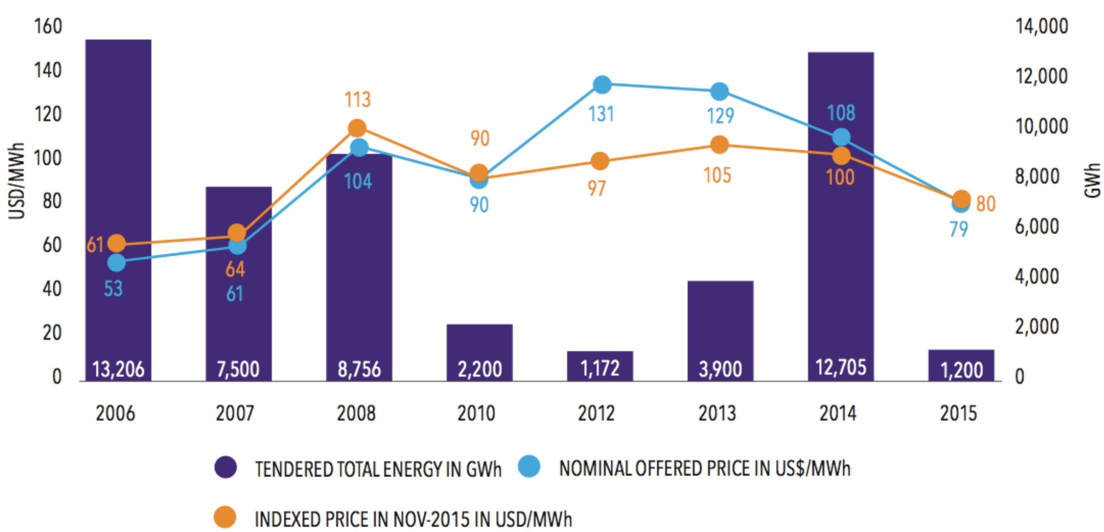


Figure 2.20. Evolution of prices offered in electric power tenders. Source: CNE (2015).

2.4. Timeline of events

In order to organize and start unraveling the dynamics of the transition process, I identified the most important events that took place in the last two decades and listed them in the following timeline. The list include relevant events of different nature. Events are grouped into categories that I considered relevant for the understanding and untangling of the story, which are the following:

- *Important events,* which gathers relevant historic events for the energy sector in Chile that took place from 1997 onwards.
- *Most salient protests,* which is included as social movements, particularly through avid opposition, are considered to have played an important role in the transition process that will be described in detail later.
- *Civil society events,* which lists important events other that protests — especifically documents or activities— that were carried out/organized by civil society organizations, especially environmental NGO and other activists.
- *Emergence of trade associations,* lists the year in which trade associations were created, which are also entities that have played a crucial role in the development of the transition process.
- *Policies and programs,* lists policy documents and special programs that have been released in recent years and relate to renewables' deployment.
- *Government's institutional structure,* is a section that track changes on the institutional structure of the energy sector in Chile.
- *Legislations,* lists all the relevant laws that were passed and affect the deployment of renewables.

In the next section I will start describing the process by linking the events presented below.

Important events

1997: Chile and Argentina sign the *Convention on Energy Integration*, facilitating the import of natural gas to Chile from Argentina.

1997-2004: Natural gas usage expansion in the electricity sector.

2001: The first wind power plant (Alto Baguales) is connected to the Aysén Electrical System.

2004: Gas supply from Argentina starts suffering cuts.

2005-2010: Expansion of coal installed capacity for electricity generation.

2006: First small hydro-power plants are developed on part of new market entrants.

2007: First wind farms are connected to the SIC (Parque eólico Canela).

2007-2013: Drought period.

2008-2013: Period of very expensive energy prices in Chile.

2010: Major reduction of solar energy subsidies in Spain.

2012: First 1MW photovoltaic plant started to operate providing energy to a state-owned mining company National Copper Corporation of Chile (in Spanish *Corporación Nacional del Cobre de Chile*, CODELCO). The project was a joint venture elaborated by the Spain-based Solarpack and CODELCO.

2014-2015: Boom of renewables' projects, especially solar and wind.

2015: Beginning of works to connect the two main electricity systems SIC-SING.

2015: Electricity interconnection with Argentina (Andes-Salta).

2015: Construction of Chile's first geothermal plant begins.

Most salient protests

2005/2006: Opposition from communities to electricity generation projects starts to emerge mostly founded on environmental grounds.

2005-2015: Conflict around the *HidroAysén* project started in 2005. The counter-campaing *Patagonia Sin Represas* begun to operate in 2007. In 2011, there were massive protests at a national level against the enterprise. The project received environmental approval but the Committee of Ministers discarded it in 2014. Finally in January 2015, the generation companies announced they will not continue with the project.

2008-2010: The conflict around the thermoelectric power plant *Barrancones* started in 2008, and involved the construction of a coal plant for electricity generation in a national reserve in a coastal zone in the north of Chile. Though the project got environmental approval in 2010, after that President Sebastian Piñera himself decided to call it off.

2009-today: The conflict around the *Castilla* coal thermoelectric plant started in 2009, and it is still not completely over. The project intended to build the greatest coal power plant in Latin America, to be installed in Northern Chile, in an area where fisherman and inhabitants think it will prejudice fishing and people's quality of life. The project got environmental approval but in 2012 the Chilean Supreme Court ruled against it.

2010-today: The conflict around the wind farm project Parque Eólico Chiloé erupted. The plant was planned to be installed in the Chiloé island in Southern Chile. This conflict has been the most important one involving NCRE technologies. It was planned to be built in the beach of *Mar Brava*, in an area where people fear it might affect tourism or the great biodiversity of the site, and which is also an important archaeological site for indigenous communities that inhabit the area. The conflict around the project is still latent.

<u>Civil society events</u>

2003: First law proposal for the promotion of renewable energy source in Chile, proposed by NGO Chile Sustentable, was handed to the government.

2008: Publication of one of the first studies of Chile's renewable potential "*Potential contribution of non-conventional renewable energy sources and energy efficiency to the electricity mix, 2008-2025*" elaborated by Universidad de Chile and Universidad Técnica Federico Santa María, jointly with some environmental NGO and some activists.

2009: The group *Escenarios 2030* (in English *Scenarios 2030*) starts to operate as a working group constituted by actors from environmental NGOs, from different organizations, from the public and private sectors, universities and the civil society that discussed future energy scenarios and evaluated possibilities. This group continued to operate until 2014.

2011: The Commission of Citizens, Technicians and Parlamentarians (in Spanish *Comisión Ciudadana Técnico Parlamentaria,* CCTP) gets convened, in parallel to the Electric Development Advisory Commission (in Spanish *Comisión Asesora para el Desarrollo Eléctrico*, CADE) convened by the Chilean government, both for discussing energy policy issues.

<u>Emergence of industry associations</u>

2003: Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*, ACERA)

2007: Chilean Association of Solar Energy (in Spanish *Asociación Chilena de Energía Solar*, ACESOL)

2008: Association of Small and Medium Size Hydroelectric Generation Plants (in Spanish *Asociación de Pequeñas y Medianas Centrales Hidroeléctricas*, APEMEC)

2009: Chilean Association of Geothermal Energy (in Spanish *Asociación Chilena de Energía Geotérmica*, ACHEGEO)

2011: Industry Association of Generators of Chile (Asociación de Generadoras), which groups big electricity generation companies.

2015: Association of Marine Energy (in Spanish *Asociación Chilena de Energía Marina*, ADEMAR)

<u>Policies and programs</u>

2005: Start of the Country Energy Efficiency Program (in Spanish *Programa País Eficiencia Energética*).

2008: Publication of the document *Energy Policy: New Guidelines*.

2009: *Chile: Energy Policy Review* elaborated by the International Energy Agency (IEA).

2011: Electric Development Advisory Commission (in Spanish *Comisión Asesora para el Desarrollo Eléctrico*, CADE) gets convened by the government.

2012: *National Energy Strategy 2012-2030* is launched during the government of President Piñera.

2014: *Energy Agenda,* a new program for the development of a new energy policy is launched by the new government.

2015 The new Chilean energy policy *Energy 2050*, which establishes a set of long-term goals for 2050, is launched by the government.

<u>Government's institutional structure</u>

2007: Separation of the energy jurisdiction department (National Energy Commission, in Spanish *Comisión Nacional de Energía*, CNE) from the Ministry of Mining.

2009: Creation of the Ministry of Energy.

2009: Creation of the Chile's Renewable Energy Center (in Spanish *Centro de Energías Renovables*, CER) is created for supporting renewables' deployment. This agency was part of the Chilean Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*, CORFO).

2010: Creation of the Chilean Energy Efficiency Agency (in Spanish *Asociación Chilena de Eficiencia Energética*, ACHEE).

2014: The CER is replaced by the Center for Innovation and Development of Renewable Energy (in Spanish *Centro de Innovación y Fomento de Energías Renovables*, CIFES).

2014: Creation of Regional Energy Secretariats (in Spanish *Secretarías Regionales Ministeriales*) throughout Chile.

2016: The CIFES is closed and the creation of the new Solar Industry Committee is announced.

Legislation

2004: Law Nº 19.940 is passed, also called Short Act I (in Spanish *Ley Corta I*), which improves the safety of the energy supply transportation system and exempts transmission charges for new renewable energy sources below 20 MW of capacity.

2005: Law Nº 20.018 is passed, called Short Act II, which improves the safety of the energy and electricity sector.

2008: Law Nº 20.257 is passed, called NCRE law, which requires utility companies to produce 5% of their electricity from NCRE sources by 2014, with the target rising 0.5% per year to 10% by 2024.

2012: Emissions regulation for thermoelectric power plants is passed.

2012: Law Nº 20.571 is passed, called *Net-Metering Law*, which regulates the payments of tariffs for residential generation, establishing discounts and refunds when applicable.

2013: Law Nº 20.698 is passed, called Law 20/25, which makes changes to the NCRE quotas previously established, increasing the requested energy on generating companies that perform withdrawals. Growths defined in this regulation mandate that by 2025, 20% of the total energy generated must come from a renewable source. This law was an initiative of a group of parliamentarians.

2015: Law Nº 20.805 is passed, which modifies the General Law of Electrical Services regarding supply tenders, replacing the old system of biding for power blocks to one that allows bidding for hourly energy blocks.

2016: Law Nº 20.928 is passed, called *Tariff-Equity Law,* that introduces equity mechanisms for diminishing the differences in electricity bills between urban and rural areas.

2016: Law Nº 20.936 is passed, called *Transmission Law*, which creates a new transmission system and a new independent coordinating institution (new CDEC for the new interconnected SIC-SING system).

2.5. Describing the Chilean energy transition

The shift on the electricity generation mix presented in the previous sections depicts a change that has taken place in Chile's electricity sector. This section attempts to connect the historical facts and figures previously presented in order to make sense of the underlying evolving dynamics that allowed and enabled that change. The information that follows was gathered and triangulated through the document review and the multiple interviews conducted to key actors of the transition process.

2.5.1. Energy security and the gas crisis

Perhaps the first event that starts to mark a shift in the Chilean energy mix towards renewables is the gas crises that the country starts experiencing in 2004. As it was pointed out previously, Chile practically counts with no indigenous fossil fuel resources (coal, oil and natural gas). In the 90s, the solution for the growing energy demand was thought to be the cheap natural gas imported from Argentina. The government encouraged the import of natural gas, the private companies that dominated the sector were on board with that and thus expansion plans were built over those expectations. Chile signed agreements in 1991 and started importing from his neighbor across de Andes in 1996. This is how from 1996-2004 all energy infrastructure development grew mainly in terms of natural gas. Indeed, up until 2003, almost all future expansion projects recommended by the National Energy Commission were combined cycle gas turbines, including projects to be ready in 2013 (CNE, 2003).

The natural gas crises finally erupted in 2004, when Argentina announced the decision to cut natural gas exports to Chile. The combination of a scarcity of domestic conventional energy resources, reliance on a single supplier of natural gas and the intermittency of hydropower left the country vulnerable to energy supply disruptions. This vulnerability was evident in 2007/08, when the combination of a drought in the central-south region and almost total restrictions by Argentina on natural gas exports to Chile resulted in an acute energy crisis. Figure 2.21 shows how gas restrictions from Argentina to Chile increased from 2004 onwards. Figure 2.22 shows the an average of rainfall statistics from 11 measurement locations across central Chile, and Figure 2.23 shows the evolution of the estimated total amount of energy contained in dams (reservoirs, lakes and lagoons relevant) for the period between 2005 and 2015 in MWh. Some experts in Chile had predicted the crises, arguing that Argentina had lowered investment in the sector and was recovering from the economic crises that had affected it, and existent agreements were weak, but skepticism dominated and no contingency plans were elaborated. The government worked on different strategies for dealing with the energy crisis, in an era when energy demand was steadily increasing. The immediate solution for Chile's energy problem was to rely on diesel and derivatives to satisfy energy necessities in the short-term, and in the long-term, the cheapest solution for the growing energy need of Chile's economy was thought to be reliance on coal, and Chilean companies started to build thermoelectric plants and to import coal massively. This is how the installed capacity in the years between 2005-2010 grew mainly in terms of coal-powered plants, and the country shifted from a natural gas mix to be mainly dependent on coal during those years (see Figure 2.14).

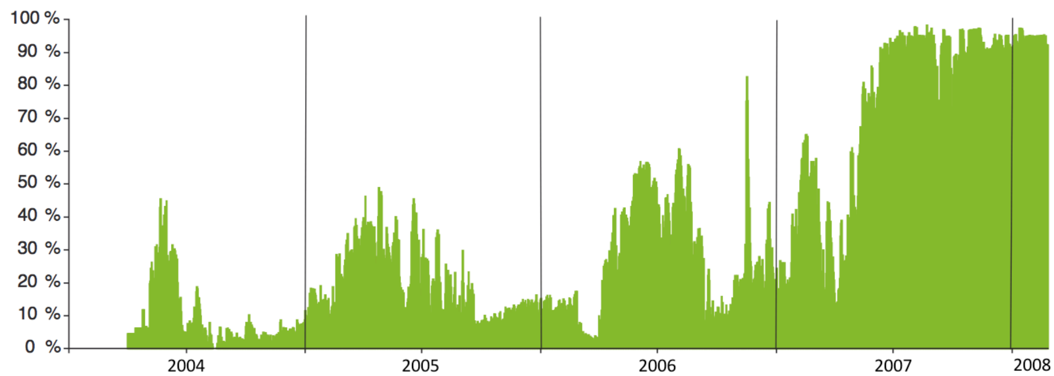


Figure 2.21. Gas restrictions from Argentina to Chile as percentage of normal requirements.
Source: Larraín and Quiroz (2008), data retrived from CNE.

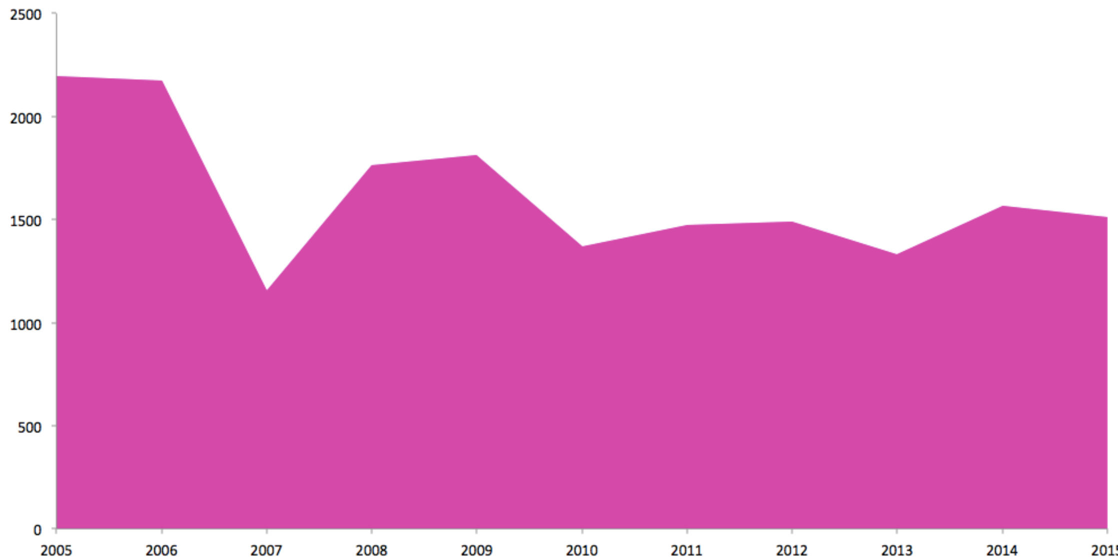


Figure 2.22. Average rainfall in mm from 11 measurement locations across central Chile. Data retrieved from CNE (2015).

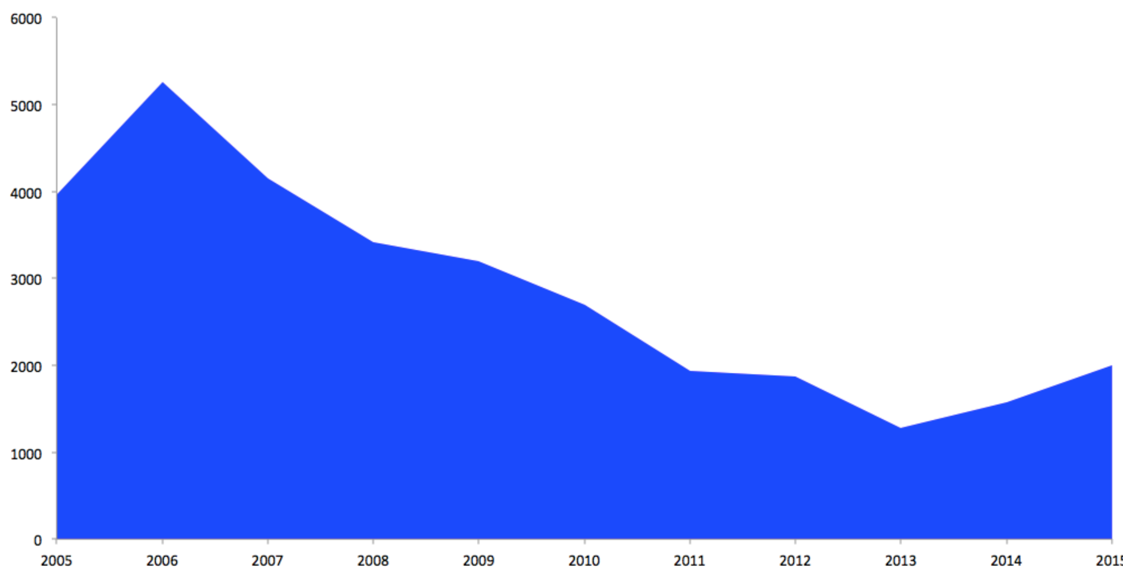


Figure 2.23. Evolution of the estimated amount of energy contained in dams (reservoirs, lakes and lagoons relevant) in MWh. Data retrieved from CNE (2015).

But controversies rapidly started to arise due to do the pollution associated with thermo-electricity generation, and soon projects started to face massive opposition on part of communities and environmental NGOs, and it turned out to be very difficult to build more projects of the kind in Chile. Hydroelectric mega projects were also conceived as a possible solution, but they faced similar opposition also on environmental grounds and were impossible to materialize.

2.5.2. Environmental NGOs and their constant push for renewables

Among the first that had come up with the idea of encouraging the use of renewable energy sources for electricity generation were national environmental NGOs. In the early 2000s, environmental NGOs, in particular Chile Sustentable along with some activists, had started raising (mostly unsuccessfully) the issue of generating electricity from renewable energy sources, publishing some general studies that started pointing out the availability of renewable energy resources in the country and its potential, advocating also for the need of focusing on energy efficiency. In 2003 they had formally proposed to the government a law draft (Chile Sustentable, 2003), proposing the implementation of subsidies for the development of renewables. At the time, they handed the proposal to the government and were able to push the first modifications in the law that started opening a way for renewables' deployment. They pushed for the implementation of incentives for renewables, but were only able to get commitment for a modest incentive, namely the exemption of transmission charges: total for small projects below 9MW (including NCRE) and partial for NCRE projects between 9 MW and 20 MW (Short Act I passed in 2004) (see Chile Sustentable, 2003).

2.5.3. The option of renewables and the quota law

By gathering information from interview subjects working for the government currently and when the corresponding decisions were taken, I was able to triangulate the following.

Around 2006-2007 some government officials started to seriously consider the option of electricity generation from renewable energy resources as a mean for diversifying the country's electricity generation mix and increasing energy security. The Argentinian gas crisis coupled with a severe drought in 2007-2008 and that left the country in an acute energy crisis, in a period when electricity demand was growing steadily.

According to the government's diagnosis, renewable energy sources were being developed in other countries (mainly in Europe) and were showing promising price expectation curves for the incoming years, though renewable energy technologies were not being developed promisingly in the country. The government identified two factors that were preventing the proper deployment of renewables in a country that counted with plenty of natural resources: (1) traditional generators were used to their classic technologies, they had the know-how on them and had not enough incentives for making the effort of investing in these new technologies at a much smaller scale, and (2) new entrants were not willing to take the risk that entering in the Chilean electricity market required.

At the time renewable energy technologies, solar photovoltaic and wind turbines in particular, were not cost-effective, but prediction curves indicated positive projections. Government officials in office evaluated available options looking at the experiences of other countries (mostly Europeans) and decided to adopt a quota strategy instead of the commonly used subsidies. People working in the government at the time argue that the reasons for picking that decision were multiple:

a. Subsidies were not justified, as it was considered that European countries had already subsidized the development of these technologies.
b. Subsidies are a very difficult alternative in the Chilean context characterized for a predominant neoliberal regime. The country is not used to the implementation of such instruments due to the strong political forces that determinedly oppose market intervention.
c. Chile as an emerging economy cannot afford to spend money in subsidizing clean energy technologies as there are other priorities.

When considering the possibility of encouraging the use of renewables in the country the government had three objectives in mind: energy security, economic efficiency and environmental sustainability. With all, different policy decision-makers at the time confirm that the most relevant objective was to diversify the generation matrix, which was a matter of energy security because of the imports dependence Chile had, as well as for increasing competition in the sector with the aim of lowering energy prices. Thus, at the beginning, the Chilean energy transition was not mainly driven by the intention of seeking sustainability.

Government leaders from the energy sector at the time explain that the intention of the government's decisions was to establish a market for renewables. In that sense the quota law was thought to be enough for accomplishing that objective. At beginning, the government proposed a law with 5% of electricity generation mandatory coming from non-conventional energy sources, but the parliament finally approved Law Nº 20.257 which requires that big generation companies with more than 200 MW of installed capacity guarantee that at least 10% of the electricity generated every year come from NCRE sources (either their own or contracted), with the percentage gradually increasing in 0.5% every year from 2014 onwards until 2024 when 10% of the generation mix must come from NCRE sources.

In Chapter 4 I will explore more deeply what has been the role of the government in the electricity transition process; what motivated leaders to make the decisions they chose and how energy policy objectives evolved over time.

2.5.4. Opposition from the traditional energy sector

The discussion of the quota law was not straightforward. The diversification of the energy generation sources was being forced by means of imposing a burden on big generators. Interviewees described that the law faced huge opposition mainly on part of the three big generation companies that dominated the market at the time (and still do so). They were supported by conservative think-tanks and by right-wing congress people (who are generally ideologically against market interventions). The opposition stand on the grounds that renewable electricity generation was expensive, and was not affordable for a developing country like Chile, whose CO_2 emissions were less than 2% of the World's.

The renewable energy quota law was supported by government officials, environmental NGOs on environmental grounds, and an emerging private sector interested in doing business in the renewable energy sector. Congress people massively supported the law and in spite of the opposition, the bill was passed in 2008 with no votes against (just a couple of abstentions). Interviewees generally believed that people from the parliament supported it on environmental grounds, as well as driven by ethical and equity considerations. Interviewed policy-makers think also that the parliament in general was aware of the energy crisis that the country was facing. These reasons coupled with the massive opposition that communities were presenting to the development of conventional energy projects at the time.

2.5.5. A renewables' market starts to develop

There is general consensus across interview subjects on the fact that the quota law implemented in the country sent a positive signal to the electricity market and a renewables' market started to develop even without the implementation of subsidies. Importantly, as the development of the renewables' sector in Chile was triggered mostly by new entrants that were not associated to big capitals, the availability of financing options for making investments was crucial for the deployment of NCRE generation technologies in the country.

Hydroelectric generation plants were a well-known technology in Chile, both in terms of engineering expertise and from financial sector institutions. The NCRE law defined as non-conventional technologies in the hydro domain, only generation plants with less than 20MW of installed capacity. So far there were several projects of this technology operating already in 2005, but they were mostly big projects, or small projects associated to big ones. So new entrants to the electricity market were the ones that got interested in the small run-of-river domain around 2006. They were mainly small companies that did not have the financial resources needed to fund their projects. At the time, as interviewees from the sector described, there was almost no financing options offered on part of national banks that were not offering project finance schemes for small hydro projects. New entrants then had to reach to European funding options to develop their projects. This situation changed over time, with the NCRE law and other government initiatives that helped banks familiarize with the development of small hydro projects on part of new entrants, diminishing the perceived risk associated to these projects. This resulted in opening new entrants' access to financial options; some national banks started then offering project finance schemes for small run-of-river projects and that set a precedent for other banks to follow. Interviewees also noted that the government worked in partnership with the private sector helping overcome other regulations' hurdles that had to be adapted to suit the new market.

The first wind farm installation built in Chile that generated electricity for one of the main electricity systems in the country (the SIC) was Endesa's Canela project. Interviewees commented that it was of common knowledge that the Canela wind farm was not planned to be a cost-effective competitive facility, but rather it was built in 2006 for other strategic reasons of the company. Other companies also built wind generation projects for strategic reasons or corporate social responsibility but there was not much dynamic development in the sector until years later.

Importantly, so far NCRE projects in Chile (considering only wind farms or solar photovoltaic generation) have been developed by international companies mostly coming from Europe, which already had experience in the renewables' development projects. Indeed, the end of subsidies for the solar industry in Spain around 2010, and the slow dynamism of the sector in general in Europe at the time seemed to have contributed importantly for developers to gain interest in the Chilean electricity market. The existence of the NCRE law, in addition to high energy prices, strong economic growth, a rising energy demand, and a good reputation for doing businesses in the country made of Chile an attractive market for future renewable energy developments. This is how Spanish, Italian, American, German and French companies got interested in developing projects in the Chilean NCRE sector. Importantly, such companies were mostly developers (not associated to big capital) so many of them needed to get financing for their projects. Moreover, many of them hoped to design and/or built a project for selling it afterwards (they did not have the intention of operating the plants).

The first cost-effective projects (considering only wind farms or solar photovoltaic generation) were funded mostly by multilateral organizations such as the Inter-American Development Bank (IDB), International Finance Corporation (IFC) or the Latin American Development Bank (CAF). Interviewed private and financial sector executives recognize the role that these organizations played in Chile in opening the market for renewables and being willing to take the risk of financing the first projects in the renewable energy sector (a risk that national financing institutions were unwilling to take). Some of the international companies that had come to Chile to develop projects also had access to their own funding sources, including international investment groups or loans from other countries, which became more available when the first pilot projects started to succeed.

As interview subjects described, it was not until later around 2013/2014 that the national financial sector started to get seriously interested in investing in these new energy technologies, after witnessing the development of many successful projects. Indeed, the Chilean financial sector is very conservative and banks were not willing to take the risk that the development of new technologies entails. When the NCRE sector recently started to develop around 2005, they were still used to corporate finance schemes and were not willing to take the risk of offering project finance options for non-consolidated technologies that have not proven to properly work for a couple of decades. When the NCRE sector started to develop and national banks witnessed several successful enterprises, they started to learn how these new technologies operated and were willing to offer them financing possibilities.

2.5.6. Government's role, institutions and international support

Energy became a much important issue in the country along the way of the transition —in part causing it but also caused by it—, with the energy sector acquiring much more preponderancy than it used to have before. Beyond the regulations that were passed, several institutions were created, and evolved, and some even got replaced over time. Some of these institutions responded to the necessity of better organizing and managing the energy sector in general, like the Ministry of Energy in 2010, and others were launched specifically for advancing the development of NCREs in the country, such as the Renewable Energy Center (in Spanish *Centro de Energías Renovables*, CER). Importantly, not only the institutional apparatus of the energy sector become more consolidated, but Chile also started to design its own energy policy —something the country did not quite have before— and evolved towards having a much more involved government's role in energy planning, as subsequent regulations and policy documents attest. Later in this chapter I will come back to some of these issues, and then in Chapter 4 I will elaborate more the discussion on the role that the government has had in the development of the Chilean transition, how government's institutions evolved and what supportive policies and incentives for renewables were implemented.

Importantly, the Chilean Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*, CORFO) and the CER —which lately became the Center for Innovation and Development of Renewable Energy (in Spanish *Centro de Innovación y Fomento de Energías Renovables*, CIFES)—, has contributed in facilitating the opening of the market for renewables in the country, as well as in the opening of financial options for the NCRE sector. Interviewees highlighted that these agencies offered grants to fund preliminary pre-investment feasibility studies, worked hardly on attracting of foreign investment, and were important intermediaries in helping national banks to learn about the sector and sweep away perceived risks (see MaRS, 2015; and Carlino, 2016). Other favorable policies implemented by CORFO for incentivizing renewables' deployment include low-interest loans for renewable energy investment, capital guarantees and risk capital funds, a clean technology fund, and a carbon tax. The carbon tax was implemented in 2014, and charges generators operating thermal plants with installed capacity equal or larger than 50 MW $5 per ton of CO_2 released. This tax is intended to incentivize plant operators to invest in clean technologies to reduce emissions.

Notably, the pre-investment grant offered by CORFO was partly funded by the Germany's KfW Development Bank. Indeed, since the late 1990s, the Chilean government has received support from Germany through the German Society for International Cooperation (GIZ) on energy matters. Interviewees noted that the GIZ has worked close to the government helping in exploring and mapping out the country's renewable energy potential, training workers, and giving the government advice in sustainability and energy policy matters.

Though not as intensively as Germany, the US has also supported Chile in advancing renewables' use. Indeed, the CER (which lately become the CIFES) was launched with support from the US Department of Energy and the US National Renewable Energy Center (US ITA, 2013).

2.5.7. Socio-environmental conflicts [2006-2017]

Pollution scandals started to erupt massively from 2006 onwards due to emissions and industrial residuals related to coal-based electricity generation (see INDH, 2015). The communities started to reject massively thermoelectric projects mostly on environmental grounds, especially in the north of the country. Along with that, strong opposition against large hydroelectric generation projects started to arise from 2005 onwards, particularly with the announcement of the *HidroAysén* mega-project planned to be built in the Chilean Patagonia region (see INDH, 2015; or Patagonia Sin Represas, n.d.; or New York Times, 2008).

Interviewed experts from academia and environmental NGOs think communities opposed conventional projects formally on environmental grounds, but there were other underlying motivations such as equity reasons, lack of participation in the design process and fear to new technologies. On top of those reasons, indigenous communities in the south also opposed projects accusing them of invading sacred indigenous sites. Importantly, as Chile joined the OECD in 2010, the country acquired the commitment of consulting indigenous communities for developing projects in the lands where they live. This was established in the Indigenous and Tribal Peoples Convention, in 1989, and referred to as ILO Convention 169 (in Spanish OIT 169).

As a result of the massive public opposition that conventional energy projects unleashed, they started to face long-lead times due to environmental concerns and the process of getting environmental approval from the Ministry of the Environment to move forward (see US ITA, 2013). This massive opposition to large-mega projects many times led to legal disputes (called "judicialization" in Chile, in Spanish "*judicialización*"), with the projects eventually left undeveloped in many emblematic cases —*Hidroaysén, Castilla, Barrancones*— due to a Supreme Court's ruling or even a governmental decision of discontinuing certain projects (for more on *Hidroaysén* see Hall et al., 2009 and Rodrigo and Orrego, n.d.; on *Castilla* see Infante Correa, 2015; on *Barrancones* see Hervé, 2011).

The strong opposition that communities in general maintained against conventional energy projects from 2005 onwards was increasingly prevented them to materialize. There were also a couple of cases in which NCRE projects faced important opposition (like the *Mar Brava* case), in general they did not have to deal with such great opposition on part of communities and the general public (see Finat, 2015).

2.5.8. Social organizations continue to push for renewables

The stop of several mega-projects left a portion of the electricity demand unsatisfied offering an opportunity for the development of alternative energy technologies. Note here that communities and the general population did not advocate explicitly for the use of renewable energy resources. The role of actively pushing for the deployment of NCRE technologies was assumed by other social organizations, namely environmental NGOs and industry associations (in Spanish *asociaciones gremiales*), which had different motivations between each other but joined forces for advancing a common interest.

Environmental NGOs, as mentioned before, were the ones that had firstly started pushing for the use of renewable energy sources in the country (see Chile Sustentable, 2003). Interviewees from such NGOs noted that they continued advocating constantly for renewables' deployment and supporting communities in their protests against conventional energy projects founded on environmental reasons, even leading and organizing the opposition in many cases. They also advocated in favor of the renewables' laws, working along with parliamentarians to advance the use of clean energy in the country. In addition, they published studies of Chile's renewable energy potential, drafted law documents and did constant lobby in favor of the cause (see the list of studies under Section 2.4).

NCRE industry associations also supported actively the opening of a market for renewables motivated by a business interest, as described by developers during interviews. As it is indicated in the timeline presented in the previous Section 2.4, many of these associations emerged during the final years of the last decade and the beginning of the present one. Interviewees from all sector remarked that these associations worked hard, advocating in favor of the NCRE laws, proposing new regulations to the government, and publishing studies that backed the positive contribution of renewables to the Chilean market.

Environmental NGOs and NCRE industry associations allied for working for opening space for these new technologies. In 2013, a second law (Law Nº 20.698) that promoted the use of NCRE was passed augmenting the 10% goal of electricity generated agreed for 2024 to 20% to be reached in 2025 (the incremental percentages were also modified). This law was proposed and advanced by initiative of some parliamentarians that worked along with environmental NGOs and NCRE industry associations, which again enjoyed strong congress support. Again, the law proposal was not exempt from opposition (indeed, at the beginning the law draft proposed 25% of the electricity generated came from NCRE source by 2025, but the proposed target was finally lowered to 20%). Interviewees described that this time, generation companies from the traditional sector opposed the initiative arguing that the intermittence associated to NCRE technologies, solar and wind in particular, introduced physical complications to the electricity grid that prejudiced the stable and constant operation of the electricity system, and thus they opposed the percent increase for safety and quality motives.

Together, the two groups of social organizations also led a couple of instances where different institutions from the civil society got together to talk about energy policy and renewables deployment. These initiatives were (1) the CCTP and (2) *Escenarios 2030* (see respective published documents Escenarios 2030, 2014; CCTP, 2011). The group *Escenarios 2030* (in English *Scenarios 2030*) started to operate in 2009, and was a working group constituted by actors from environmental NGOs, from different organizations, from the public and private sectors, universities and the civil society. The group was convened by an alliance of institutions and energy-sector stakeholders, and aimed to open a discussion space of different potential scenarios of energy and electricity generation for 2030, with the aim of generating insights for the elaboration of energy policy. The group continued to work until 2014. Additionally in 2011, after the massive protests against the *Hidroaysén* project that took place in May that year, a group of environmental NGOs and congresspeople organized the Commission of Citizens, Technicians and Parliamentarians (in Spanish *Comisión Ciudadana Técnico Parlamentaria*, CCTP). This commission came together to discuss energy issues due to the rejection to a similar commission convened by the Chilean government (Electric Development Advisory Commission, in Spanish *Comisión Asesora para el Desarrollo Eléctrico*, CADE). The commission included parliamentarians, environmental NGOs, professors and technicians, and gremial organizations in the renewable energy sector. The commission published an outcome document with a series of proposals arguing *"Chile needs a Great Energy Reform: Proposals for the transition towards an electricity development that is clean, secure, sustainable and fai*r".

Both environmental NGOs and NCRE industry associations were able to take advantage of the window of opportunity that the constellation of contextual factors and actors opened up for renewables. They constantly advocated in favor of renewables' development putting pressure on the government and working vehemently for the development of the new regulations that contributed to open up the market for renewables. Their role will be revisited and studied in depth in Chapter 3.

2.5.9. International influence and technology transfer

One aspect that draws attention from the Chilean transition story is the international influence that the country received. Evidence indicates a transferring process of knowledge, technology and financing.

Chile has been influenced on environmental sciences, renewable energy technologies, and climate change-related policy-making. The ideas that environmental NGOs embraced —the need for switching from conventional energy technologies towards renewable energy generation given climate change and biodiversity threats— came from abroad, as well as the know-how for recognizing the business opportunity that NCRE industry associations identified. Moreover, social organizations (environmental NGOs and industry associations) received direct support from international NGOs like the Natural Resources Defense Council (NRDC), the Greenpeace and the WWF (World Wide Fund for Nature), as well as from individual experts and activists that were interested in supporting their causes (e.g. Professor Stephen Hall and the philanthropist Douglas Tompkins) (evidence from this can be found on the different reports that were published at the time, see the list in Section 2.4). Trends from the developed world also impacted the vision of government officials, who after studying paths followed by European countries and prices curves decided to adopt a similar (but different) path, as they described in the interviews. Renewable energy policies, as well, were designed guided by the experience of pioneer countries from the developed world (mostly from Europe and the US), also with the support from the GIZ. More recently, even sustainability trends penetrated policy visions. Indeed, interviewees noted that international trends on environmental sustainability and climate change played an important role in explaining why conventional energy technologies started to face major opposition from the civil society in general.

So far, the Chilean transition has not included the development of new technologies, which means that practically all the technology that the transition has profited from is imported, especially in the solar PV and wind energy sectors. Turbines, solar panels and electronics equipment were mainly imported from Europe, but more lately also from China (both solar panels and wind turbines). Development companies that came to Chile include SunEdison (American), SunPower (American), Mainstream (Irish/European), Vestas (Danish), ABB (Swiss), Abengoa (Spanish), Acciona (Spanish) and Siemens (German). They came in search for new market opportunities, when European governments started to diminish subsidies to renewables in Europe, attracted by the good market conditions that Chile had to offer, especially good macroeconomic conditions and FTAs, and high energy prices. In addition to that, interviewees mentioned that Chile is also seen by European transnational corporations as a good platform for entering the Latin American market. All the know-how on the design of NCRE generation systems and their operation, and on the integration of NCRE to national electricity systems also came from abroad, mostly from Europe. Experts from Germany, Spain and other European countries started to arrive to develop projects, and many Chilean engineers and technicians also traveled to Europe to get training. All this on top of the financing options that international developers were able to access abroad and the funding coming from multilateral organizations.

2.5.10. Energy prices were soaring

Many factors contributed to the high energy prices that Chile started to face in 2007, when the effects of the gas crisis combined with a severe drought in 2007/2008 (the drought period lasted until 2013/2014, but it was not as severe as it was in the beginning) hit the country. That coupled with high international prices of oil, as well as with a period of high coal prices. Due to the lack of supply resources, generators were allowed to burn diesel when necessary to fulfill their contracts, and they ended up passing most of the difference in costs on to the users, as they were allowed by the regulation to do so. In addition, the difficulties for materializing new projects of cheaper conventional energy technologies due to social opposition added another complicating factor. In fact, during the crisis years Chile's energy prices were amongst the highest in Latin America (US ITA 2013; MaRS, 2015). Electricity prices were so high that the situation made the country one of the few markets where renewable energy were able to compete without incentives.

Importantly, there are no accusations that claim to market power collusion as the cause of the skyrocketing prices at the time, but rather people in the government think it was indeed expensive to generate electricity in Chile, and that impacted in a similar way generators' expectations.

2.5.11. The renewables boom 2014-2015

The combination of good conditions for the development of renewables resulted in a rapid expansion of NCRE sector in the Chilean electricity market, and allowed a boom of solar photovoltaic plants and wind farms projects in the country in 2014 and 2015. Among the factors that interviewees identified as having contributed to the increasing development of NCRE projects in Chile are: the availability of high-quality renewable energy resources, high energy prices, the fact that conventional energy projects faced strong oppositions from communities across the country, the increasing availability of financing, the existence of a stable regulatory framework, the commitments sustained by the government to continue to support renewables' deployment, promising energy demand expectations (Figure 2.24 shows demand projections in 2012), and the improvements in efficiency, as well as the continuous drop in technology costs, especially of PV panels and wind turbines. Indeed, the low cost of renewable energy production represented by the levelized cost of energy (LCOE) of NCRE technologies, solar PV and wind farms in particular, continue to drop astonishingly over time, being the most striking example the cost drop of PV plants: the capital expenditure of fixed-tilt PV plants fell from USD 3.42/W in 2010 to USD 1.61/W in 2012, a reduction of more than 50% in just two years (Bloomberg 2015). Figure 2.25 shows how the LCOE prices of solar PV and wind technologies compared to LCOE of traditional fossil fuel technologies. Wind technology prices dropped in prices heavily before 2009, while solar PV technology prices dropped impressively after 2010. This in contrast to fossil fuel technologies that have mostly maintained their prices.

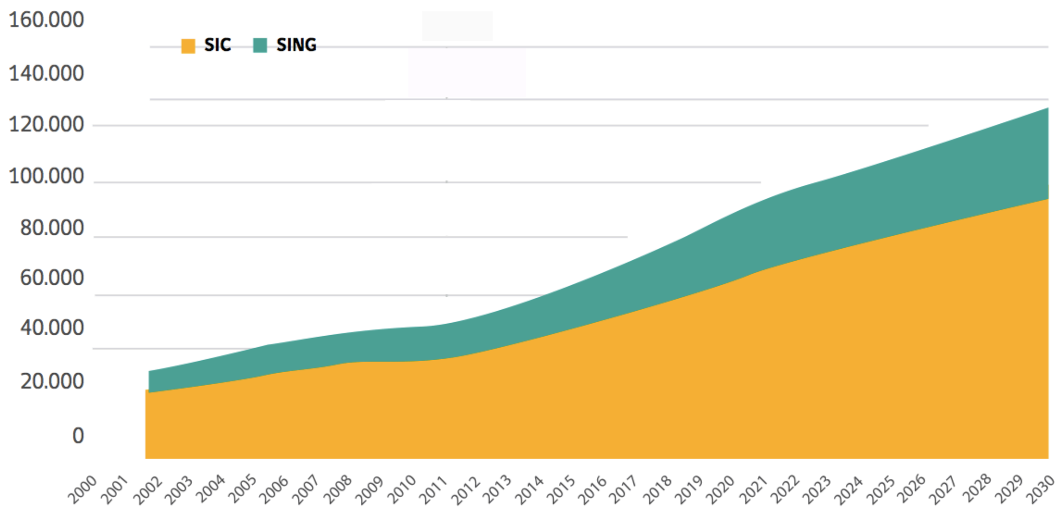


Figure 2.24. Predicted energy demand for Chile, as published by the National Energy Strategy 2012-2030. Source: CNE (2012).

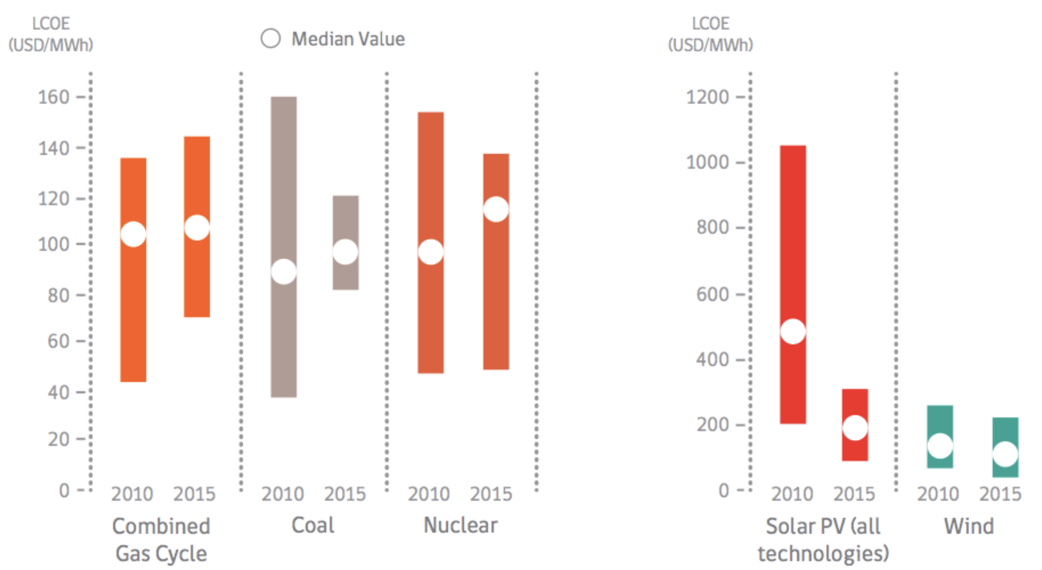


Figure 2.25. Evolution of LCOE (Levelized Cost of Energy) from 2010 and 2015. Source: Ministry of Energy (2015), data retrieved from , as published by the International Energy Agency.

By the means of all the aforementioned factors it turned out that rapidly it was economically convenient to develop renewable energy power plants, even without the presence of subsidies. Indeed, the described conditions contributed to reach the so-called *grid parity* of NCRE technologies (solar PV plants and wind farms) earlier in Chile in comparison to other countries (roughly around 2013-2014) (see Finat, 2015).

The boom was also enabled and fueled by the increasing availability of financing. Developers from the NCRE sector remarked the critical importance of this point, especially because most of the international companies that had come to Chile to develop projects were not associated to big capital, with many of them being interested only in designing and/or building plants hoping to sell them afterwards to be operated by other companies. At the beginning, some of the first NCRE projects of new technologies (for the cases of both solar PV and wind farms) were designed for self-consumption. Given the high prices of electricity, some developers decided to take the risk and enter the electricity market selling energy to the wholesale market at spot prices, i.e. without a contract at a fixed-price (PPA), and some were able to get contracts with private mining companies that attempted to lower their extremely high energy costs. When energy prices were very high and spot prices reached 200 USD/MWh, the risk was worthwhile and returns of those projects were massive (see Figure 2.26). As mentioned before, these first enterprises were financed by multilateral organizations (in their role of opening markets), such as the IDB and the IFC. Some others by private investment (or loans) that developers were able to get from abroad, especially after the successful performance of the first pilot projects.

As these new technologies become more familiar and national banks witnessed many successful examples, they started to be willing to offer financing options, as indicated by interviewees from the financial sector. At first they were willing to fund projects that were going to be financed selling energy to the wholesale market at spot prices, but as more and more renewable energy projects entered the market bottlenecks started to occur in the transmission system revealing its flaws. In fact, at some generation nodes were solar PV projects overcrowded transmission lines, marginal costs even dropped down to zero as the variable cost of solar PV generation is virtually zero, so those enterprises started receiving no remuneration for the electricity they generated (this will be discussed in more depth later).

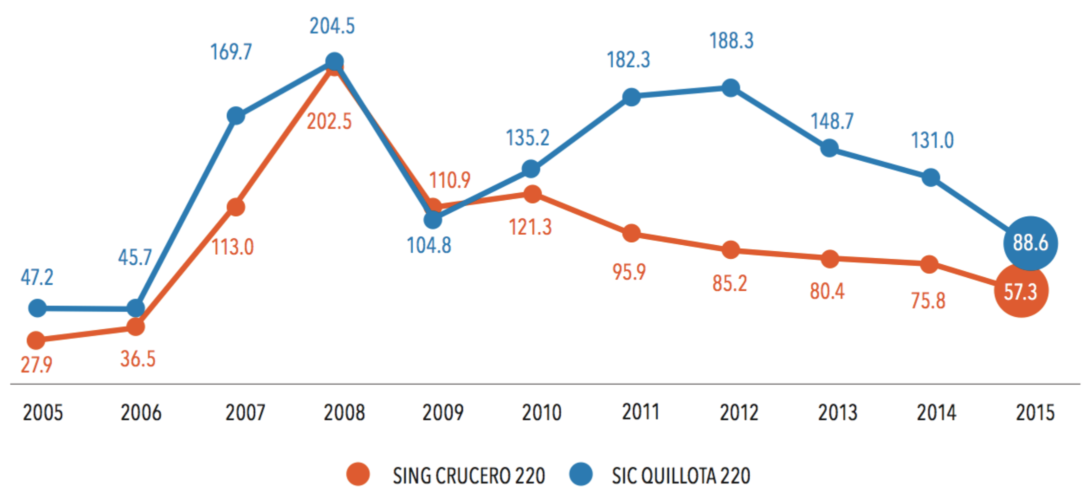


Figure 2.26. Average marginal costs evolution between 2005-2015 in USD/MWh. Source: CNE (2015), data retrieved from CNE, CDEC SING and CDEC SIC.

As spot prices suffered from high variability and lack of predictability, in 2016 banks were not willing to take the risk of the spot market any more, and stopped funding projects that did not have PPAs. Obtaining a contract though is difficult in Chile as *free clients* are not quite familiarized with these technologies and instead are used to buy power blocks that guarantee a constant amount of power, something that renewables cannot offer. The alternative option was then to appeal to public tenders to get the desired contracts that allow developers to get funding from local banks.

2.5.12. An important change in public tender regulations

In order to overcome the problem of getting access to PPAs, renewable energy developers, mainly through NCRE industry associations, started to advocate for modifications in the regulations that ruled public tenders. In those tenders, generation companies used to bid on power blocks for supplying electricity to distribution companies that serve regulated costumers, which represent approximately 55% of the market. In 2014 when Máximo Pacheco assumed the lead of the Ministry of Energy office, he openly received the proposal from NCRE industry associations for replacing the old system of biding for power blocks, for one that allows bidding for hourly energy blocks. The change was implemented through law Nº 20.805, passed in 2014, and allowed variable NCRE generators to participate in public tenders, as they now can bid during the hours that they generate electricity. The law also trespassed the responsibility of organizing public tenders from distribution companies to the National Energy Commission.

The first public tender subject to the new rules was conducted in the second half of 2014, there was a second one in 2015 and a third one that was closed in July 2016. The change in public tender regulations had been a recognized success by all actors in the sector, as energy prices have consistently and significantly dropped as a result of the increase in competition and the entrance of competitive NCRE technologies. Figure 2.20 presented before shows how energy prices have been falling in public tenders, and to that we have to add that in the tender that took place in 2016 prices finally fall to 47.6 US$/MWh (Diario Estrategia, 2016). Average marginal costs also show a decreasing tendency, as depicted by Figure 2.26.

2.5.13. Transmission problems and the new transmission law

With the boom of new NCRE projects joining the electricity grid, transmission problems started to become evident. Multiple zones started to suffer from bottlenecks, particularly in a zone called Norte Chico, in the northern part of the SIC, where too many solar PV power plants where installed, motivated by high radiation levels of the Atacama Desert. Figure 2.27 corresponds to a graph elaborated by Bloomberg that shows how electricity prices repeatedly fell to zero at the Diego de Almagro electricity substation in Northern Chile, in a zone considered saturated with solar PV arrangements (Bloomberg, 2016). Indeed, paradoxically, given the flaws of the transmission system the cheaper energy produced in the Norte Chico region cannot be transmitted to the big consumer centers in the central region where energy is still being generated from conventional energy sources.

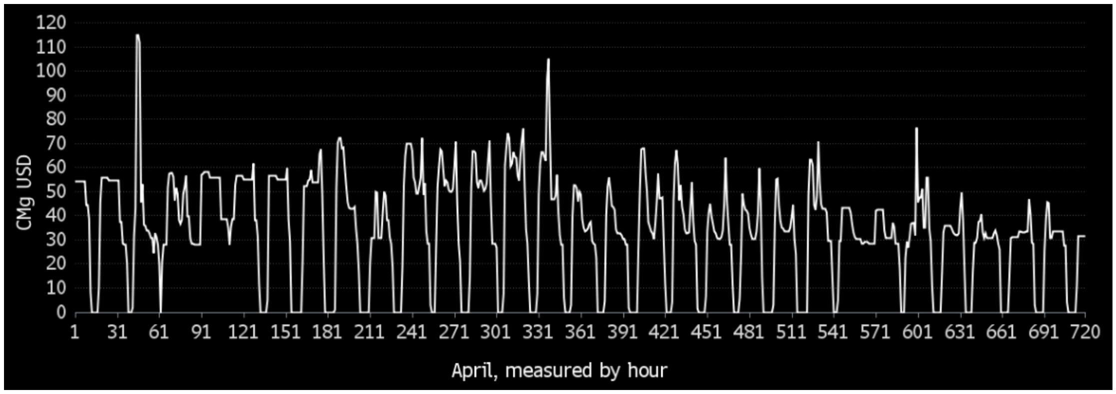


Figure 2.27. Spot hourly prices in USD for April 2016 at the Diego de Almagro substation in Northern Chile, which is part of the SIC electricity system. Source: Bloomberg (2016), data retrieved from CDEC SIC.

Some of the interviewed experts from the CDEC attribute transmission problems to the fast development of the NCRE generation sector, for which the time frames for completing projects are much shorter that the time frame that was traditionally needed for the development of conventional projects. Other interviewed subjects, including experts from the academia and the private sector (both conventional and NCRE) attribute part of the responsibility to the lack of planning on part of the state in an essentially monopolistic sector as it is electricity transmission. As a matter of fact, investments in the transmission sector lagged too behind development in the generation sector and that has caused congestion problems and has slowed down investment. In addition, transmission projects also suffer from increasing opposition from local communities and private owners, which dramatically increases development times.

In 2014 the government started working in a transmission law that modifies the transmission sector. That bill was finally passed in July 2016 (Law 20.936). Among the improvements in the sector is the interconnection of the two largest electricity systems in the country —the SIC and SING which together represent 99% of the electricity mix— forming the National Electricity System (in Spanish *Sistema Eléctrico Nacional*), which will be ready in 2018/2019. The law established that from now on there will be a single electricity system in north and central Chile, as well as a single coordination entity called *National Electricity Coordinator* (in Spanish *Coordinador Eléctrico Nacional*), which will imply the merger of current CDECs in a single institution. It also establishes improvements in the transmission sector's planning. The sector now is going to be assessed every year by the CDEC and the CNE, and this would allow them to make recommendations to new entrants and incentivize/dis-incentivize developments in certain sectors, and that will help preventing transmission problems. Importantly, investment in the transmission sector will still be subject to private willingness to pursue it.

Most interviewed subjects with technical expertise expect that the bottlenecks and the majority of the transmission problems will be solved when the interconnection between the SIC and SING materializes, but its real impact remains to be seen.

In Chapter 4 I will revisit the Chilean transmission sector and analyze more in depth the limitations that it imposes over the electricity system as well as the planning role that the government has increasingly assumed over the last decade.

2.5.14. *Energy 2050* policy

After the privatization of the electricity sector in Chile during the dictatorship in the 80s, the sector has been governed by market principles. Aligned with the neoliberal ideology that has prevailed in the country, the role of the state has been to intervene only when the market is not operating properly. Until recently the country had no specific energy policy, and it was of common knowledge that "the energy policy in Chile was not to have a policy", as pointed out by several interviewees.

In 2004 and 2005 the government passed two transmission laws (Short Act I and Short Act II) designed for improving flaws in the transmission system. Around 2007/2008, when the effects of the gas crisis and a severe drought stroked the country, the necessity of having a well-defined energy policy that granted energy security and economic efficiency in the sector started to become evident. In 2008, the Chilean government published a document called *Energy Policy: New Guidelines* (CNE, 2008), which was a first manifesto towards the design of a formal energy policy. After that in 2012, the new government in office, with more right-wing political views replaced the previous document with a new energy policy called *Energy Strategy: 2012-2030* (Ministry of Energy, 2012). When the current left-wing coalition recovered the presidency in 2014, they published a strategy for designing a formal long-term energy policy called *Energy Agenda* (in Spanish *Agenda Energética*), which they wanted to be "socially validated" (Turner and Astudillo, 2014). In line with that aim the *Energy Agenda* defined a participatory process for the development of a new energy policy. The government started to seek participation as a necessary strategy for generation projects to move forward. The opposition of empowered communities to projects form conventional energy technologies, and even to some NCRE projects, made it necessary to change the traditional unilateral approach that electricity generation projects have traditionally had. The private sector asked the government for help in dealing with communities for being able to move forward with their projects. The government then started to seek participation as a way to legitimize not only the outcome policies but also the processes through which decisions were made. A participation division was created at the Ministry of Energy and, though they are just beginning to learn about participatory processes and their role raise some skepticism and critiques, they represent a completely new way of doing policy in Chile, and their effort is valued widely among stakeholders in the sector.

After two years of work that included experts committees, policy committees where they try to convene all stakeholders in the sector, and working groups in all of the country's regions that were open to the general public, the government published the new energy policy called *Energy 2050* (Ministry of Energy, 2015) at the end of 2015. The policy has been criticized on different fronts, including the missing actions that the government will follow to achieve the stated goals and the questionable participatory process.

All energy policy documents, starting with the *Energy Policy: New Guidelines* document (CNE, 2008), so far have expressed explicit interest on part of the government for the deployment of the NCRE sector. At first achieving sustainability was not and end in itself, but as international tendencies have moved towards that direction, Chile has also started to embrace sustainability as a fundamental objective. The *Energy 2050* document even sets a goal for achieving 70% of the Chilean energy mix coming from renewable energy sources by 2050, including non-conventional sources as well as large hydroelectricity projects.

In Chapter 4 I will review the different energy policies that the Chilean government has launched, the role that renewables' had in each of them as well as how the concept of sustainability got incrementally incorporated into energy policy decisions. In Chapter 3 I will revisit the concept of participation and how such value got incorporated into the ways in which energy policy is formulated in contemporary Chile, and the challenges and opportunities associated with it.

2.5.15. Outcomes of the transition to date

Up-to-date the electricity transition has implied multiple changes in different domains. First of all, it has implied a shift towards a less carbon-intensive electricity mix, with around 13% of the electricity generated in the country coming from NCRE sources. This is way beyond the law requirement, as it is shown in Figure 2.28, which depicts the increase in the amount of electricity generated from NCRE over the last years and how it has largely surpassed the obligation requirement mandated by law.

To the best knowledge of the author, there is only one engineering-economic study that tries to measure the impacts of renewables in the Chilean economy, though unfortunately it assesses future scenarios instead of analyzing data from past events. The study was developed by Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*, ACERA) and published by the International NGO NRDC (2013), and it is called: *Economic Benefits of Non-Conventional Renewable Energies in Chile* (published in Spanish under the title *Beneficios Económicos de Energías Renovables No Convencionales en Chile*). That study compared two scenarios of renewables' penetration, one with the current scenario at the time of 10% renewables to be reached by 2024, and the other considering an increase of the penetration percentage to 20% by 2020. The study concluded that the net benefit under the higher penetration scenario would be at least US $1,600 millions for the period 2013-2028, though most reduction of environmental impacts was not quantified.

There has also been a diversification in terms of energy sources, and the incorporation of new entrants to the market has also resulted in a diversification of the actors in the electricity market, which has welcomed new international and national developers and investors. As a result, competition has increased in the sector that is now less concentrated, and that in turn has had a positive impact of electricity prices (Finat 2015, Estrategia 2016) that have consistently dropped (see Figure 2.26).

More recently, incumbent companies (Endesa, Colbun and Aes Gener) have slowly started to invest in renewables. Endesa was acquired by the Italian multinational Enel in 2014, and with that their subsidiary Enel Green Power came to be in charge of the renewable energy sector of the company. Enel Green Power has acquired and developed several projects in Chile including solar PV, wind, and hydropower initiatives that sum up to a total of more than 1000MW. In 2012, Colbun, attracted by the successful results of NCRE initiatives and the business opportunity the sector presents, called for a public tender for subscribing agreements with renewable energy companies and agreed with Acciona Energía (a Spanish company operating in Chile) on a 12-year PPA for purchasing power to be generated by a wind farm that is expected to generate 124 GWh annually. Colbun also signed a 15-year contract with the American company SunPower, for buying 500 GWh of solar energy per year from a solar PV plant of 164 MW. Moreover, in 2016, SunEdison, an American company operating in Chile, filed for bankruptcy protection and agreed to sell 202 MW of solar projects in Chile to Colbun. In contrast, Aes Gener has shown much less interest on NCRE technologies, and so far they only have a solar PV plant of 21 MW that was built in 2014, which they plan to expand to 220 MW at some point to be defined.

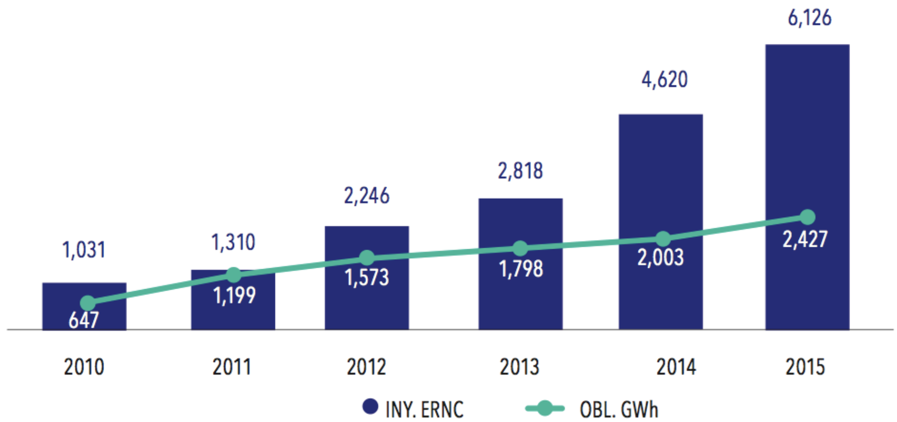


Figure 2.28. Evolution of NCREs power production recognized under Law Nº 20.257 in GWh. Source: CNE (2015), data retrieved from CIFES.

The transition has also entailed changes in the way participation is incorporated in energy policy-making, as well as in the way electricity-related projects are developed. Indeed, after much mobilization and opposition in the sector, the way in which energy policy is conceived in the country has changed, and now it reflects a much more participatory approach. The Ministry of Energy has decided to create a participation unit that focuses on opening spaces for participation and deliberation with communities, and even the new *Energy 2050* policy strategy was a product of a much more deliberative policy-making process. Despite the critiques of government's efforts, there is wide recognition of the relevance of the steps that have been undertaken in this regard. There has been a change then towards a more participatory way of energy policy-making. Along with that, there has been a change in the way of doing business in the sector. Indeed, it was common to hear from all private sector executives that now business development does not only concern investors and engineers, but it involves new spaces for engaging with the communities that inhabit and work in the areas where projects are to be developed, especially for trying to create businesses' alliances with them, in an attempt for unifying forces and taking advantage of the synergies of doing business together. Indeed, one of the opportunities that the NCRE sector quickly took advantage of was the need for a new approach for developing projects. This is something that has particularly characterized the green energy sector, and that I think has greatly helped the transition to move forward.

The renewables' transition has also entailed a change in the government's way of guiding and doing energy policy. In the last decade the Chilean electricity market has been subject to several regulatory reforms, evolving from a completely liberalized market to one that steadily involves more regulation. Additionally, the government has started designing and proposing energy policy strategies, as leaving control of the sector completely in hands of the market has proven to be an insufficient strategy (this point will be further elaborated in Chapter 4).

The concept of sustainability has also been increasingly (though slowly) incorporated into Chilean energy policy. At the beginning changes in electricity regulations were focused on opening renewables a space to compete with the incumbents in fair conditions. By then, nor regulations were driven by a vision of favoring clean energy technologies neither sustainability was conceived as a primordial objective. As time has passed and international trends related to climate change and environmental sustainability have raised more awareness, Chile has incrementally incorporated sustainability objectives to the core values of its energy policy.

It is worth highlighting that the integration of clean energy sources has represented a diversification of Chile's electricity mix as well as a diversification of actors in the electricity market welcoming new international and national developers and investors, but it has not yet involved a shift from the natural resources extractive model that has traditionally characterized the Chilean economy towards a more manufacturer profile. In recent years the government (mostly through CORFO) along with some research universities have tried to incentivize technological development related to the energy industry, particularly related to the solar resource (the replacement of the CIFES by a new Solar Industry Committee was announced in May 2016) since it is believed that Chile might have a comparative advantage thanks to the Atacama Desert, as it was noted by interviewees from CORFO, the Solar Energy Research Center (SERC Chile) and the Fraunhofer Center for Solar Energy Technologies in Chile. But though efforts are positively evaluated by many interviewed actors, its impact is yet to be seen.

In addition to the above, another important aspect to keep in mind is that the Chilean transition has not (yet) involved an innovation process that comprises the development of new technologies. However, it has involved the adoption and diffusion of new NCRE technologies that were not used in Chile before. The Chilean case study depicts the reality of developing nations, which are not very likely to make deliberate investments in technological innovation as Western European developed nations have done, but are rather more likely to implement and adopt technologies already developed and tested by developed countries. In that sense, Chile's case might offer some insights on how a transition can be triggered within the context of developing countries, that generally lack the necessary resources for implementing (significant) subsidies and fostering technological innovation, do not have clear sectoral policies, and need important efforts for expanding their institutional capacity. Chile, in particular, is considered among the leader nations in Latin America, so this case might be especially useful as an example for triggering and managing other transitions in the region.

2.5.16. Current state of affairs and future perspectives

To date, the situation in Chile with respect to renewables is characterized by several issues that pose challenges for the transition to continue moving forward. From the perspective of NCRE developers, the general panorama looks as follows:

Transmission. Currently, electricity systems in Chile suffer from curtailment problems, though expectations are very positive on part of developers and experts that I spoke with, who have faith in the new transmission law and the interconnection SIC-SING, and expect they will solve the most important problems of the transmission system.

Social conflicts. So far, despite fragile relationships with local communities, NCRE companies that have adapted their business development models are generally able to move forward with their projects. Though as NCRE projects proliferate, NCRE developers increasingly struggle to get social acceptance. In this regard, the government has been trying to develop guidelines for developing projects in a more participatory way, but defining clear limits and obligations both for communities and developers is still pendant. Several interviewees noted that a particular problem developers are increasingly facing is the appearance of unscrupulous people (including lawyers and community leaders) that try to take advantage from the development of what is seen as a millionaire project, trying to sue companies for questionable motives hoping to get money compensation from developers for their own personal benefit. Another issue that relates to the existence of social conflicts is the lack of land-use policy in the country. So far, the decision of where to install a plant (and whether to install it or not) has relied unilaterally on generators, until this had to start changing due to the opposition that this raised on local communities. Some institutions and scholars have raised this issue and the government is starting to address the necessity of having a well-defined land-use policy. The new transmission law for example contemplates some government intervention on the definition of where transmission lines will be located, but this planning role is still mild and territorial organization remains a pending matter.

Energy demand expectations. There are is a lot of uncertainty related to energy demand expectations in Chile. Copper, the principal commodity that the country exports and which exploitation represents the major industrial consumption of electricity in the country, has suffered dropping prices in recent years and as a result investment in the sector has drooped too. Figure 2.29 shows the evolution of investment in Chile by sector, from which it is possible to observe how investments in the mining and energy sectors are related. The figure also shows the stagnation of the mining industry in recent years, which is likely to be reflected soon in the energy sector.

Financing. Developers still find it difficult to get access to financing options, especially due to the difficulties for signing PPAs. The change in tender regulations represented a huge improvement, but the volatility of energy prices in Chile, the problems with communities and the uncertainty of energy demand still entail financial risks that Chilean banks are reluctant to incur.

Non-regulated customers. Interviewed NCRE developers think the market of *free clients* (non-regulated consumers) is still a big market niche that remains to be exploited in the electricity sector. Indeed, non-regulated clients consume around 45% of the electricity generated in the country, but they have not yet become regular clients of NCRE generators. Interview subjects believe that *free clients* are still used to buy constant amounts of power and do not want to take the risk of signing contracts with generators from intermittent technologies. They believe there is a need for a change in their perception in order for them to experience a similar mind-change as it was done in public tender regulations, so they open-up to start trading energy blocks instead of a fixed amount of power.

Human capital. International reports as well as the experience of developers in the sector indicate that Chile lacks skilled labor force (US ITA 2013; MaRS, 2015). In fact, many foreign people work in the sector at all levels as a result of a lack of Chilean prepared workers. Most developers get contracts with construction companies from abroad because they generally charge less and have more experience than national firms. Currently, there are some ongoing initiatives of training and educational programs developed by the government and the GIZ, but this is still too modest for satisfying the raising demand.

Ancillary services regulations. There is also an urgent need for the creation of an ancillary services market that allows for guaranteeing the quality and reliability of electricity services, especially given the increasing amounts of generators from variable technologies that are entering the market. The regulation for ancillary services was pendant for about 7 years (for no specific reason), and was finally passed the last day of 2012. The transmission law passed in June 2016 comprises the creation of a regulatory framework for an ancillary services market (and improves the existent regulation), though its design is still in progress.

Marginal cost system. Many developers also think that there is a need for a change of the marginal cost system that Chile utilizes for remunerating generators who trade electricity through the wholesale market. This, considering the expansion on NCRE technologies, which generally entail a cost structure that is different from the one that have traditionally characterized conventional energy technologies. Renewables require big up-front costs and they have very low operational costs, while fossil fuel generation technologies generally had expensive operational costs. For that reason, as it is happening in Northern Chile, when solar plants fill the entire transmission capacity of a line, they start receiving practically null remuneration for the electricity they generate, as their marginal cost is almost zero.

Distributed generation. In 2012 Chile passed a net-metering law that allows consumers that generate their own electricity to sell their surplus to the grid. Nonetheless, this law has been heavily criticized because residential generators' tariffs are way lower than distribution companies' tariffs (around 50% lower). Thus, so far it is not economically convenient for regular home-owners to install their own power arrangements. Indeed, in Chile the transition has been enacted by private NCRE enterprises, as opposed to the case of Germany where renewables deployment was firstly advanced by cooperatives and small developers. A more sophisticated and appropriate distribution law, in which the country is already working partly financed by an IDB loan approved by the end of 2016, would allow Chile to move a step forward towards energy democracy. So far participation has been confined to energy policy-making and to limited consultation processes for large generation facilities.

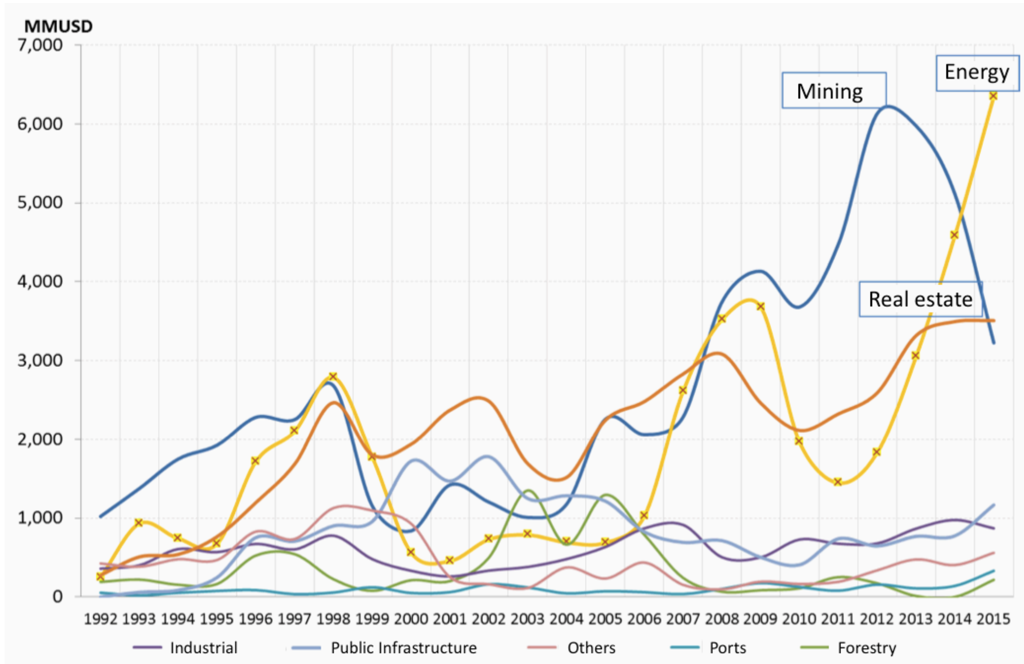


Figure 2.29. Evolution of investment in Chile by sector. Source: Data was retrieved from *Corporación de Bienes de Capital* (CBC), as published by Pacheco (2016).

Technological development. There is also the pending issue of taking advantage of the renewables' transition for embarking in local technological development, for start shifting from the extractivist model that has so far characterized the country to one that develops and manufactures technology. The government and the academia have put their hope in the solar industry. The government created a special program for fostering the solar R&D, and the academia is also focused on advancing adaptation capacities of existent technologies for the special radiation conditions of the Atacama Dessert. Though efforts are valuable, foreign experts I spoke with in formal interviews (or informal conversations) seem to coincide in thinking that this might not be an appropriate niche to put all efforts in, especially given China's strong leadership of the sector. Many of them think that Chile should focus on a much less developed technology that might offer both comparative advantages and less strong competition, as it is the case of marine energy.

With all, most interviewed developers and experts think that the renewables' sector will continue to develop in the country. At least for the immediate incoming years, Figure 2.18 shows a continued development of the NCRE sector, and existent laws ensure at least 20% of the electricity generation mix coming from NCRE by 2025. After that the continuity of renewables' development remains to be seen, though the goals published in the *Energy 2050* policy augur (but not guarantee) a promising future. In Chapter 6 I will discuss more in depth each one of the challenges for the future of the Chilean transition and propose a series of policy recommendations for dealing with them so as to be able to take the most advantage from the opportunities that the transition is offering to the country.

2.6. Analyzing policy paradigm change

For starting to analyze the Chilean transition process, I begin evaluating if the case represents an important change in Chile's energy policy approach. For performing the analysis, I utilize Kern's et al. (2014) proposed framework for analyzing policy change. Kern's et al. (2014) framework is built upon Hall's (1993) original work on policy paradigms. Hall (1993) identifies a policy paradigm as a framework of ideas which influences the way in which policy is formulated in a given policy area. This framework of ideas influences the ways in which problems are perceived, the setting of policy goals and the selection of the most appropriate instruments (Hall, 1993). Hall suggests that a policy paradigm shift only takes place when the objectives and instruments of policy are replaced by new ones. Furthermore, Oliver and Pemberton (2004) add that these new institutions need then to become embedded for a true shift to have occurred.

Researchers have suggested that policy paradigm changes are likely to start occurring at moments of crisis. Indeed, crises might offer an opportunity for political agency, as they highlight flaws of existing policy paradigms allowing their credibility to be challenged and giving space for alternative policy paradigms to be accepted and institutionalized (Hay, 1996; Blyth, 2002; Oliver and Pemberton, 2004, as phrased by Kern et. al 2014). It is important to highlight though that crises are many times events that need to be narrated and explained as constituting a problem in order to direct attention to a certain policy issue (Blyth, 2002; Widmaier et al, 2007). Indeed, a crisis narrative needs to be able to establish the shared perception that a crisis exists across a range of actors, that existing policy is failing to solve the crisis, and needs to recommend alternative policy solutions that should be pursued (Blyth, 2002; Hay, 2001; Stone, 1989).

Kern's et al. (2014) propose a framework for analyzing policy paradigm change that consists of four interrelated levels: 1) ideas about the subject and how it should be governed (interpretive framework); 2) policy goals; 3) policy instruments; and 4) governance institutions. A policy paradigm shift can be claimed when significant changes can be identified which depart from existing practices on each level of the policy paradigm between two time periods.

Table 2.1 exhibits a characterization of two contrasting moments; before the period under study and at the very end of it (current situation). Table 2.1 shows that Chile's energy policy paradigm has changed quite substantially on every level outlined in the framework. Note that I have added a fifth level that compares the main challenges of each period for further enriching the comparison.

Kern et. al (2010) further argue that besides applying their proposed framework for assessing the occurrence of policy paradigm changes, it is necessary to look deeper into the dynamics and narratives of the process to understand how and why change has taken place. I have started scrutinizing that in this chapter, though I will explore and analyze in more depth these relationships in the incoming ones.

Table 2.1. The energy policy paradigm change in Chile, using the framework for analyzing policy paradigm change proposed by Kern and Kuzemko (2014).

Level	2004	2016
Interpretive framework	Neoliberal electricity paradigm: • Energy/electricity conceived as a tradable commodity • Electricity to be traded and supplied through competitive, freely trading markets • Market expected to distribute energy resources and enable energy trade in an economically efficient manner • Implicitly assumed that free markets would deliver constant energy supply • State intervention needs to be minimized and limited to technical and administrative functions	• Energy less seen as a normal commodity and more as a public good that requires some degree of strategic planning • Markets are understood as not to always lead to socially desirable/preferable energy outcomes • Chilean society expects the State to play a role in planning and management including stakeholders in the definition of a market-oriented strategy • Renewables perceived as valuable indigenous energy resources that need to be at the center of the Chilean energy policy strategy
Objectives of policy	• To provide electricity at the lower cost through competitive electricity markets • Lack of a long-term energy policy for the country • Neither environmental sustainability nor energy security were considered core values of the sector in the electricity legislation	• Energy sector is expected to provide reliable, inclusive, competitive and sustainable energy • Four pillars of new energy policy vision: quality and security of supply, energy as a driver of development, environmentally-friendly energy, and energy efficiency and energy education • Long-term renewable energy policy objectives as part of the formal national policy strategy
Instruments	• Minimum regulatory framework for incentivizing investment in the sector and the achievement of economic efficiency • State intervention limited to technical and administrative functions	• Quota laws implemented in 2008 and 2013 to ensure that renewables could enter the market • Change in public tender regulations to enable renewables to access the regulated clients' market • New transmission law recently passed for unifying the two main electricity systems and dealing with curtailment problems • Other complementary policies, such as information gathering on renewable energy potential or promotion of the Chilean energy sector for international investment, were also implemented by CORFO committees (CER, CIFES)
Governance institutions	• The energy sector was governed by the National Energy Commission that was part of the Ministry of Mining until 2007 • Superintendence SEC in charge of overseeing the Chilean energy market • Load Economic Dispatch Centers (CDECs) as the private entities responsible for coordinating the operation of the electricity system	• Ministry of Energy created in 2010 managing the energy sector and formulate policies • CORFO committees created to foster renewable energy generation. The CER was created in 2010, replaced by the CIFES and then further replaced by the new Solar Industry Committee • CNE in charge of analyzing and regulating prices, setting technical and quality operational standards, monitoring and forecasting expected performance of the sector • SEC in charge of supervising energy and electricity prices
Main challenges	• Instability of energy supply • Lack of a long-term energy policy that establishes clear objectives and priorities • Limited institutional infrastructure	• Transmission expansion (bill recently passed in mid-2016) • Restructuration of the marginal cost system for remunerating electricity generation • Managing social conflicts of projects • Fostering renewable energy technological development

2.7. Final comments

In the current chapter I presented the general story of the Chilean transition and started characterizing it in terms of the MLP. In the three following chapters I will further elaborate on the dynamics of the Chilean transition, for then zooming out again to look at the big picture and overall transition dynamics in Chapter 5.

In Chapters 3 and 4 I will explore in more detail two key aspects of the transition. In Chapter 3 I will take a closer look on how niches developed and were able to break-through in the prevailing regime of the Chilean electricity sector, focusing on the role that social organizations —environmental NGOs and NCRE industry associations in particular— played out in that process. In Chapter 4 I will explore the role that policy and the Chilean government has had in the transition through the creation of institutions and by passing regulations that have modified the structure of the electricity market.

CHAPTER 3. ANALYZING THE POLITICS OF THE CHILEAN ENERGY TRANSITION: THE ROLE OF SOCIAL ORGANIZATIONS IN FOSTERING SOCIO-TECHNICAL CHANGE

3.1. Introduction to the chapter

This chapter analyzes the politics of the Chilean energy transition, specifically exploring the role that social organizations —namely environmental NGOs, industry associations and social movements— played in enabling a change towards the integration of renewables into Chile's electricity mix to start taking place.

Avelino et al. (2016) argued that by their nature, "transitions involve politics in the broadest sense of the word, that is, as all the activities of co-operation and conflict, within and between societies, whereby the human species goes about organizing the use, production and distribution of human, natural and other resources in the production and reproduction of its biological and social life", as defined by Leftwich (1983/2010). Thus, by studying "the politics" I refer to the analysis of the ongoing struggle for power and influence that underlies policy change, which is played out in significant part through arguments about the "best story" (Fischer, 2003). In this chapter then, instead of focusing on analyzing of the type of policies implemented within the Chilean transition (which will be covered in Chapter 4), I focus on exploring the power struggles embedded in that policy process.

From policy studies we know that political processes take place in the interplay between ideas, actors and institutions. Actors are embedded in a certain political economic structure and institutions of contemporary society, and exercise their role in policy-making through their interactions. These interactions are imbued with meaning from the ideas that actors invoke in supporting or opposing particular policy options (Howlett et al., 1995). Studying political processes then implies identifying the key actors in a policy process, what brings them together, how they interact and what effect their interaction has on policy-making and policy outcomes.

As it was described in Chapter 2, from 2005 onwards, Chile started to experience a shift in its electricity sector. The amount of electricity coming from NCRE sources has increased considerably from the early 2000s to mid-2017, and is expected to continue in the following decades. One of the important milestones of the Chilean transition is the way in which different forms of social organizations have participated in it. Interestingly, along with the constellation of economic factors and governmental efforts that have certainly determined the outcomes of Chile's electricity transition story, up to date it seems to have been also a consequence of a mix of social factors that aligned and contributed to the changes that can be observed so far. In this chapter I explore the ways in which environmental NGOs, industry associations and social movements took part and affected the transition, and argue for the fundamental role that policy entrepreneurs as them might play in affecting transition dynamics.

In the next section I discuss the literature on how politics and power affect transition dynamics and present ways in which the policy analysis literature might contribute to the study and understanding of transition processes. After that, I analyze the role that politics, and social organizations in particular have played in the Chilean transition and theorize on how the Chilean case can shed light on the study of transition policy processes. With the aim of situating the research case in the context of transition studies, I finish the chapter making a brief comparative analysis between my findings from the Chilean case study and insights obtained from other case studies of national electricity transition politics available in the literature. Finally, I conclude with a set of lessons from the case that might contribute to understand general light on how political processes may affect other transitions.

3.2. Literature review and discussion

As sustainability transitions is an interdisciplinary field that involves problems that cover a multiplicity of actors, sectors, and factors, researchers commonly make connections with different specialized fields of study that might offer useful insights on certain aspects of transitions. In this chapter I look at the policy analysis literature, as well as to literature on power and transitions, and to social movements studies for analyzing and understanding the forces and dynamics that have played out a role in the Chilean transition case.

3.2.1. The politics of transition processes

Early research in the emerging field of sustainability transitions has focused mostly in developing management strategies and related policy instruments, for steering transition processes. This, perhaps, in part as an outcome of the "European bias" idea described by Markard et al. (2012) that points out the fact that the field of transition studies has a tendency for theories founded on a basis of European cases. As such, Hess (2014) notes that in Europe there is a broad policy consensus in favor of a transition for the energy sector, and thus the issue of political conflict over sustainability transitions is less important theoretically, and the focus of research tends to involve issues of management and policy implementation. But the reason might be also in part for what Meadowcroft (2005) and Kuzemko et al. (2016) highlight; the idea that the notion of transition is drawn primarily from literatures on technological change, rather than on politics or sociology.

More recently several scholars in the field have started to point out the crucial necessity of studying the politics of transition processes. They have argues that sustainability researchers "have focused largely on policy, devoting much less attention to the political circumstances that make the adoption of such policies likely" (Meadowcroft, 2011). Meadowcroft (2009, 2011) argued that *politics matter* for transition processes and that different political contexts will make a difference to the outcome of sustainability transition policies, with political circumstances ultimately determining the adoption of certain policies. Using the Multi-Level Perspective's (MLP) language he argues that politics will play a potentially powerful role in an eventual transition by defining the landscape, propping up or destabilising regimes, protecting or exposing niches, among other possible effects.

Kern (2011) argues that, as political processes, the politics of transition processes lie at the very interplay of ideas, with existing institutional arrangements and interest-based politics. According to Meadowcroft (2011) ideologies/ideas influence the definition of problems and the understanding of acceptable solution spaces, institutions (understood as organizations) frame political interactions and shape the boundaries of possible outcomes, and political interests (involving existent and new groups of political actors) determine the emergence of reform coalitions, the creation of new centres of power and the organization of social movements. Importantly, Smith et al. (2005) noted that socio-technical change will involve issues of agency and power, with transition advocates trying to exert influence (agency) for transforming the dominant socio-technical regime, likely encountering resistance from incumbent regime members. Indeed, transitions will necessarily entail a structural change with both losers and winners, in a power struggle that is likely to involve high stakes and important distributional consequences (Smith and Stirling, 2010). This is why Smith et al. (2005) noted that "it is likely that any attempt to side-step incumbent regime members and foster alternative regimes will meet strong resistance by incumbent regime interests", and then making a difference will require the exercise of political, economic and institutional power (Smith et al., 2005).

This is why researchers have argued for the irreducibly political character of governance for sustainable development, suggesting that long-term transformation of energy systems will prove to be a messy, conflictual, and highly disjointed process (Meadowcroft, 2009). Indeed, all the above argues for the inherently political nature of sustainability transition processes.

Considering the predominance of fossil fuel energy regimes, the necessity of leveraging a change towards more sustainable energy practices becomes imminent. From new institutionalist studies, Kuzemko et al. (2016) remark that there are a number of conditions under which profound governance changes happen, including as the result of a significant party political shift, during time of crises and uncertainty, or more gradually, via an accumulation of new rules and norms over time (Blyth, 2002; Hall, 1993; Mahoney and Thelen, 2010). They point out that change is enabled when there is recognition that a problem exists and that current technologies and/or governance schemes are not addressing these problems (Blyth, 2002; Verbong and Loorbach, 2012). The process of change is contentious and deeply political, entailing new winners and losers that are expected to be at the heart of change debates. Some case studies have noted that in some countries incumbent energy companies tend to act as forces for continuity, while new innovators act as forces for sustainable change (Stenzel and Frenzel, 2008). This chapter focuses on identifying what forces for sustainable change and what forces for regime continuity have been present in the Chilean transition, as well as explaining their motivations and the consequences of their actions.

3.2.2. Advocacy coalitions

The literature on transitions tends to acknowledge the role of advocacy coalitions in achieving socio technical change. The concept of advocacy coalitions comes from the political science literature. The Advocacy Coalition Framework proposed by Sabatier (1988) is the dominant policy theory that promotes the vision of coalitions for explaining policy change, however other theories of policy change have also incorporated the idea of advocacy coalitions (punctuated equilibrium, narrative policy framework, etc.). An advocacy coalition consists of actors from a variety of public and private institutions at all levels of government who share a set of basic beliefs (policy goals plus causal and other perceptions) and who seek to manipulate the rules, budgets and personnel of government institutions in order to achieve these goals over time (Howlett et al., 1995). What holds an advocacy coalition together are its members' shared beliefs over core policy matters. They might disagree on minor issues, but that disagreement is limited. Coalitions seek to translate their shared beliefs onto public policies or programs. Advocacy coalitions correspond to a subset of actors in a policy-subsystem within the larger political economic system (Sabatier and Jenkins-Smith, 1993). A policy subsystem is defined as a network of individuals from a variety of public and private organizations (e.g. elected officials, interest groups, experts, judicial actors, the media) who are concerned actively with the maintenance and evolution of policy in a particular domain. Advocacy coalitions engage in narrative strategies in an attempt to successfully influence the public's and decision-makers' policy preferences (Howlett et al., 1995).

The concept of a policy regime has been developed to describe the phenomenon of the persistence of fundamental policy components over a fairly long period of time, found at the sectoral level of policy-making. The term policy regime attempts to capture how policy institutions, actors and ideas tend to congeal into relatively long-term, institutionalized patterns of interaction that combine to keep public policy contents and processes more or less constant over time. A policy regime can be thought of as combining a common set of policy ideas (defined as a policy paradigm) and a common or typical set of policy actors and institutions organized around those ideas (a policy subsystem). The concept of policy regime can be linked to the concept of socio-technical regime from transitions literature, as socio-technical regimes can be assumed to have a political dimension represented by the concept of policy regime.

Coalitions for sustainable change include scientists, technology experts, NGOs, politicians, policymakers, international organizations, and consumers/voters for whom environmental sustainability is important, and industry associations, among others. Indeed, Kuzemko et al. (2016) note that they increasingly include investors in the form of the recently successful, UN backed, divestment campaigns like Fossil Free UK. They note that what unites these broad coalitions is the drive for sustainable change, though there is considerable diversity visible in the broad, but not always commensurable, range of solutions offered.

Likewise, forces for regime continuity (incumbent coalitions) can be equally diverse. They are not only constituted by corporate actors but represent much broader coalitions that include independently influential groups such as banks, pension funds and other associated supply chain actors with sizable investments in energy regimes. In the case of the energy sector, they can also include climate skeptics, politicians and large and small energy consumers, particularly those focused on the cost of energy over other factors (Geels, 2014; Kuzemko et al., 2016).

Policy studies scholars have pointed out the complementary nature of advocacy coalitions theory and policy entrepreneurship concepts (Mintrom and Vergari, 1996; Mintrom and Norman, 2009). Mintrom and Vergari (1996) suggest that advocacy coalitions theory could be improved by incorporating insights from policy entrepreneurship on how coalitions form, and also on how policy innovation become articulated onto the political agenda. Mintrom and Norman (2009) argue that within the advocacy coalition framework, change is anticipated to come from both endogenous and exogenous shocks. But, to have political effect, those shocks need to be interpreted and translated. This process of translation is directly equivalent to the process of problem definition, whereby objective social, economic, and environmental conditions are portrayed in ways that increase the likelihood that they will receive the attention desired of decision makers. Policy entrepreneurs typically display skills needed to do this kind of translational and definitional work. At the same time, policy entrepreneurship theorists also recognize that to gain credibility among decision-makers, policy entrepreneurs frequently must work to build coalitions (Mintrom and Vergari, 1996). In addition, other studies such as Goldfinch and Hart (2003), Hajime (1999), Litfin (2000) and Meijerink (2005), drawing on empirical evidence across a range of policy areas and policymaking venues have also indicated the merits of incorporating a discussion of policy entrepreneurship within discussions of advocacy coalitions.

Perhaps the fact that most transition studies have been developed in Europe where there are consolidated and long-lasting green coalitions has detracted attention from the role that policy entrepreneurs might play in sustainability transition processes. In different countries, especially in the developing world, such strong green coalitions often do not exist or are just recently emerging, and which might be the case due to the existence of other priorities. This implies that the occurrence of transitions will necessarily require the formation of such advocacy coalitions. This is where the concept of policy entrepreneur comes about.

3.2.3. Policy entrepreneurs

The concept of policy entrepreneurs could yield useful insights into the analysis of the politics of policymaking processes, helping to uncover how ideas enter the political arena to enact change. Policy entrepreneurship studies attempt to understand how innovative ideas get articulated onto political and legislative agendas. Policy entrepreneurs can be thought of as doing for the policymaking process what business entrepreneurs do for the marketplace, which means that policy entrepreneurs bring new policy ideas into the political arena (Mintrom and Vergari, 1996). Policy entrepreneurs are embedded in social networks. In his pioneering use of the term, Kingdon (1984/1995) noted that policy entrepreneurs could be in or out of government, in elected or appointed positions, in interest groups or research organizations. Their defining characteristic, as in the case of a business entrepreneur, is their willingness to invest their resource (i.e. time, energy, reputation, and sometimes money) in the hope of a future return.

Policy entrepreneurs seek to advance their policy ideas and to promote dynamic policy change. Indeed, contributors to the agenda-setting literature suggest that policy entrepreneurs use several activities to promote their ideas. These include identifying problems, shaping the terms of policy debates, networking in policy circles, and building coalitions. Importantly, policy entrepreneurs frequently seek to assemble and maintain coalitions to support specific policy ideas (Eyestone, 1978, Smith 1991). Furthermore, to support the selling of their ideas, policy entrepreneurs must have access to resources that can be both organizational and/or personal.

Kingdon (1984/1995) argued that policy entrepreneurs, both inside and outside of government, construct and utilize agenda-setting opportunities, labeled *policy windows*, to bring issues onto government agendas. He defined *policy windows* as "opportunities for advocates of proposals to push their pet solutions, or to push attention to their special problems". Kingdon suggested that policy windows open and close based on the dynamic interaction of political institutions, policy actors, and the articulation of ideas in the form of proposed policy solutions. These forces can open policy windows creating the chance for policy entrepreneurs to construct or leverage these opportunities to shape the policy agenda.

Hogan and Feeney (2012) criticize theories of policy change for often relying on crises or exogenous shocks for explaining policy change (Greener 2001; Golob 2003), —as their existence highlights a failing within existing policies the emergent situation (Levy 1994)—, while ignoring the role of endogenous constituents. They argue that the introduction of new ideas into the policy environment, and their transformation into policy, happens due to the activities of "entrepreneurial networks" of policy entrepreneurs, which might be either exogenous or endogenous to the prevailing political regime.

Importantly, in order for policy entrepreneurs to challenge existing arrangements, a crisis and policy failure must be identified and widely perceived (Hay, 1999). Once a crisis is identified, the failure of a prevailing policy paradigm drives policymakers to look outside government for a solution (Oliver and Pemberton, 2004). Ideas enter the political arena through particular actors who promote then and build supporting coalitions (Berman, 1998). The composition and size of entrepreneurial networks (coalitions) can demonstrate the support for an idea (Mintrom and Norman, 2009). Moreover, Kern et al. (2014) remark that frameworks of ideas can impact heavily upon processes of institutional change —which often happens during periods of crisis—, arguing that "Ideas and their expression in the form of narratives are understood as being capable of convincing groups within society that there is a crisis, that existing policy is failing to solve the crisis, and that alternative solutions should be pursued.

The role of policy entrepreneurs has been studied in water transitions (see Huitema et al., 2011; Brouwer and Biermann, 2011; Font and Subirats, 2010). Brouwer and Biermann's (2011) analysis of the strategies of policy entrepreneurs in Dutch water management leads them to argue that entrepreneurs can influence and steer transitions to some extent and hence direct policy change. Huitema et al. (2011) have analyzed sixteen instances of radical water policy change across the globe, concluding that policy entrepreneurs can affect transitions through a set of strategies, such as idea development, coalition building, the detection and exploitation of windows of opportunity, network management, and venue shopping. They argue that individuals do contribute to transitions and that they do so in collectives, dividing tasks over various members. Depending on the institutional setting they operate in, they are able to intervene in a top-down or bottom-up fashion. Huitema et al. (2011) argue that "policy change is a political game: networks must be built, issues need to be framed strategically, forums manipulated or by-passed, and strategies adjusted to the peculiarities of the institutional system the entrepreneur is working in". Font and Subirats (2010) argue that the main implication of studies on the role of entrepreneurs on water policy change is that accounts of water management transitions should place greater emphasis on the role of agency in bringing about policy change.

With respect to energy transitions, Laird and Stefes (2009) highlight the crucial role that policy entrepreneurs have had in the German transition by taking advantage of the window of opportunity for advancing that the Chernobyl disaster opened, arguing that the lack of similar circumstances explains the difference with slow development of the sector in the US.

In the context of developing countries, Steinberg (2001) analyzed the emergence of biodiversity and environmental policies in Costa Rica and Bolivia during the last four decades. Forty years ago those countries did not have a sophisticated environmental policy. By the time Steinberg wrote his book in 2001, Costa Rica's national park system was already considered to be one of the best in the world, the country had a strong environmental regulatory agency, had pioneered concepts like ecotourism and biodiversity prospecting, was home to hundreds of citizens' environmental groups, and was led by a president who made sustainable development the conceptual underpinning of his entire administration. The case of Bolivia was similar; the country had implemented a series of conservation policy innovations including the world's first debt-for-nature swap and a national environmental endowment that served as an exemplar for other nations in the region. Bolivians had designed an ambitious protected areas system administered by nonprofit organizations and indigenous groups, established an effective, high-profile biodiversity conservation agency, passed important laws for environmental protection and forestry sector reform, led the international campaign to protect mahogany, and had active environmental organizations in every major city. His study, led Steinberg (2001) to underscore the importance of both domestic policy entrepreneurs and environmental advocates, as well as transnational relations for the achievement of such policy reforms. The impact of international environmental ideas on government institutions in Costa Rica and Bolivia has been the direct result of bilateral activism, with domestic policy entrepreneurs using their political clout to insert these ideas into forestry legislation, park agency mandates, congressional committee structures, party platforms, foreign affairs ministries, and even national constitutions. He argues that policy entrepreneurs with simultaneous access to domestic and international spheres of influence have been responsible for policy innovation and institutional strengthening over a period of decades. Combining international scientific and financial resources with domestic political resources has enabled Costa Rica and Bolivia to create a series of environmental institutions that work reasonably well despite the great odds facing policy reformers in poor countries. With the benefit of both extensive international exposure and a long-term, in-country presence, they have introduced environmental policy ideas from abroad and fostered the growth of constituencies of concern at home.

3.2.4. Resistance from the regime

As argued above, the actions of policy entrepreneurs and advocacy coalitions will most likely be contested by dominant actors in the incumbent regime. Geels (2014) has argued that regime stability is indeed the outcome of active resistance by incumbent actors. Moreover, he suggests that policymakers and incumbent business actors tend to form close regime level alliances because of mutual dependencies, which often resist fundamental change. Thus, Geels (2014) highlights the importance of paying attention to the destabilization and decline of fossil fuel-based regimes, which he calls "the *destruction* part of Schumpeter's *creative destruction* concept".

Smith et al. (2005) argue that incumbent regimes constitute a kind of structured power that conditions the identities and inter-relationships of the actors they enmesh. Then the actors' capacity to intervene in transformation processes will depend on their situatedness in the conditioning structure imposed by the regime that they are trying to affect.

Hess (2014) further elaborates on incumbent regimes noting that they are not just bodies of rules and institutions but organized agents in the political field. They mobilize against transition policies that are perceived to threaten their short-term profitability and long-term existence. Established industry coalitions includes the petroleum, coal, and natural gas industries; the electrical utilities with the concerns for baseload generation and an interest in nuclear power; and right-wing think tanks and conservative political leaders who frame the green-energy transition as the improper government role in the economy.

Geels (2014), elaborating on Avelino and Rotmans (2009) concepts, distinguishes four different forms of power regime resistance: instrumental, discursive, material and institutional. Instrumental forms of power refer to actors using resources to achieve their goals and interests, for example their positions of authority, money, access to media, personnel, capabilities, etc. Discursive strategies for regime resistance refer to the use of narratives and discourses that might be used for shaping what is being discussed (setting the agenda), as well as how issues are discussed. Material strategies refer to the use of technical capabilities and financial resources to improve the technical dimension of socio-technical regimes. Finally, institutional power refers to the institutional contexts —embedded in political cultures, ideology and governance structures— that facilitate the strategies of incumbent actors and then assist regime resistance.

Understanding the politics of the Chilean transition will require paying special attention to the power struggles between incumbent companies and transition forces, with the former exerting strong resistance for trying to avoid change.

3.2.5. Social movements

Studies about social movements provide additional insight for the study of the Chilean transition case. Smith and Stirling (2010) point out that an important source of countervailing pressure for regime change lies in favorable events beyond existent policy regimes, and this includes mass mobilization of a social movement demanding greater sustainability, or a series of environmental or economic crises bestowing greater credibility on radical arguments of an advocacy coalition. They remark that at these moments, the interdependencies that made the regime so enduring can become problematic because they constrain responses to these significant new pressures. They point out though, that this is beyond the agency of those engaged with a policy coalition or entrepreneurial network, and requires them to develop a capacity for positioning themselves favorably in the light of ongoing political processes, mobilizing support, influencing agendas, and redirecting investments and other commitments away from incremental repair work and toward more radical transition goals.

Hess (2014) also remarks the importance of grassroots mobilizations of green-transition coalitions. He notes that social movement organizations will form coalitions to support sustainability policies, and they will forge frames and discourses that allow cross-movement solidarity (Mayer, 2008). He notes that green-transition coalitions might include blue-green (labor-environmental) alliances, urban political constituencies that support green jobs, and the rising industries in niche positions (e.g., green-energy industries).

Hess (2007) further theorized on the role of social movements in shaping socio-technical change. He argues that social movements and activists have played and are playing a significant role not only in scientific but also industrial innovation. He distinguishes two major types of industry-oriented social-change action: industrial opposition movements (IOMs) and related social-change action, which focus on the remediation of environmental risks and problems; and technology- and product-oriented movements (TPMs) and related social-change action, which focus on innovation of design processes.

Hess argues that IOMs and TPMs can affect industrial innovation, and they can shift the direction of the history of a technological field. Organizationally, the IOM generally consists of a network of social- movement organizations that coalesce around specific campaigns and may be coordinated through umbrella organizations. Although the moratorium is the primary goal, the IOM may have secondary goals of support for alternative technologies, e.g. democratic or local control of technological decision-making, and access for the poor. Some organizations have both IOM and TPM missions, and individuals often have biographical trajectories of work in both IOMs and TPMs. IOMs need TPMs to legitimate the call for the moratorium; in turn, the TPM supports the alternative that can replace the technology that should be phased out. Without the TPM, the IOM would be vulnerable to the criticism of mere negativism. Likewise, the TPM relies on the work of the IOM to draw attention to the shortcomings of existing or new industrial technologies, the benefits of the alternative, and the need for research funding and consumer support of the alternative.

Also from the literature on social movement theory, Geels (2011) notes that because social movements start as outsiders to existing orders (regimes), they tend to use non-institutionalized action (protest marches, blockades, leaflets, and petitions) to exert pressure. The mobilization of resources (money, members, expertise, and relations) is one mechanism that enhances the power and influence of social movements (McCarthy and Zald, 1977). But social movements also exert pressure through cultural framing, which influences the cognitive space in which issues are debated (Eyerman and Jamison, 1991). Indeed, social movements contest the dominant discourse (often articulated by technical and political elites) by engaging in framing struggles over specific issues.

For analyzing the incidence of social movements in the Chilean transition I will draw from and integrate the theoretical contributions presented above.

3.3. The role of social organizations in the Chilean transition

The Chilean transition was in significant part an outcome of the intervention of social organizations for displacing what used to be the dominant regime in Chile's electricity sector. This section details the involvement that different types of social organizations have had in the transition and in which ways they have affected resulting outcomes. The role of the Chilean government and the policies implemented within the transition will be explored in Chapter 5.

3.3.1. Social organizations

Chile does not have a consolidated green political party or coalition, neither with a particularly strong group of environmental NGOs, nor with an unusually strong group of industry associations in the electricity sector. Despite that, environmental NGOs and NCRE industry associations (called *asociaciones gremiales* in Spanish), though with different motivations, are widely recognized by relevant actors that I spoke with to have played a determinant role in the Chilean transition.

<u>Environmental NGOs</u>

The group of very active environmental NGOs in the political arena is not particularly big in Chile. There are a bunch of them that are more politically active than others. Among the most politically active in the national arena are: Chile Sustentable, ONG Ecosistemas, Chile Ambiente and the Terram Foundation. Among the international most active ones in Chile are Greenpeace Chile, the Natural Resources Defense Council (NRDC) and the Chilean chapter of the World Wide Fund for Nature (WWF). Activists leading or associated to environmental groups during the transition period include key figures such as Sara Larraín, Roberto Román, Juan Pablo Orrego, Amanda Maxwell, Matías Asun, Patricio Segura, Flavia Liberona, Patricio Rodrigo and Senator Antonio Horvath.

Chilean environmental organizations started to become explicitly interested in electricity issues in the 90s when a huge controversy around the construction of two dams in the Biobio region emerged. The controversial generation projects, called *Pangue* and *Ralco*, attempted to build two dams in the high zones of the Biobio region (in Spanish *Alto Biobio*). *Pangue* was developed between

1993 and 1996, and after that, *Ralco* was built between 1998 and 2004 (Wikipedia, 2017). Both projects raised huge controversies due to the environmental impacts associated to the construction of dams, and beyond that, both of them implied the relocation of indigenous communities that inhabited the to-be-flooded areas, dramatically prejudicing their life quality and access to resources (Memoria Chilena, Biblioteca Nacional de Chile, n.d.). The *Ralco* project in particular is today an emblematic case of inadequate project planning and mismanagement mostly due to its social and environmental negative impacts. Though the project was authorized by Chilean authorities in 1997, in 2002 Endesa (the generation company behind the project, that is also one of the three dominant in the country) was sued before the Inter-American Commission on Human Rights (Cuentas Ramírez, 2014). The court ruled requesting the Chilean government to mediate a compensation for the displaced communities. Indigenous communities finally arrived to a deal with the government and Endesa, but still more than ten years after affected communities denounce un-fulfillment of the agreements on part of Endesa (Ibid.). Environmental organizations largely joined the opposition against the development of both *Pangue* and *Ralco* projects on environmental and equity grounds (Wikipedia, 2017b). It is to be said that thanks to their sustained efforts (which will be detailed later in this chapter), the Ralco project was the last large hydropower project developed until 2010, when the construction of the Angostura project started, which corresponds to the only dam developed in the last decade (which started to operate in 2013) (Central Angostura, n.d.).

The conflicts around the Pangue and Ralco projects, in the early and late 90s respectively, were the first ones that raised massive controversy, especially on environmental and indigenous matters, and national and international environmental NGOs joined the opposition supporting the indigenous communities that were leading the opposition movement. After the conflicts, energy and electricity matters gained visibility, and issues in such a strategic and relevant sector started calling the attention of national environmental NGOs, whom after the conflict continued to advocate in favor of more sustainable ways of generating electricity. Indeed, they were the first ones in start proposing the use of Chile's natural energy resources for electricity generation in the early 2000s, publishing some general studies that begun pointing out the availability of renewable energy resources in the country and its associated potential, advocating also for the need of focusing on energy efficiency. In 2003, the environmental NGO Chile Sustentable along with some activists and experts, formally drafted a law proposal for the promotion of renewable energy sources in Chile and presented it to the government (Chile Sustentable, 2003). This proposal was the first one of its kind and involved the implementation of subsidies for renewables' deployment. The proposal was overall unsuccessful as it was not followed up by the government, but activists gained some significant accomplishments. Though they did not get governmental commitment for the implementation of subsidies (as they were requesting), they were able to get a modest incentive that exempted certain projects from transmission changes, including all NCRE projects bellow 20 MW (Short Act I passed in 2004). Moreover, the Short Act I of 2004 was the first formal document that defined the concept of NCREs that has been crucially important in the Chilean renewable energy sector and its deployment.

Motivated by experiences of developed countries and knowledge developed by the environmental scientific community, environmental NGOs were also the first ones in elaborating a study of Chile's renewable energy potential. In 2008, they published one of the first studies of Chile's potential entitled "*Potential contribution of non-conventional renewable energy sources and energy efficiency to the electricity mix, 2008-2025*", published in 2008, elaborated by the Universidad de Chile and the Universidad Técnica Federico Santa María, jointly with a group of environmental NGOs and some activists.

Environmental NGOs continued to advocate steadily in favor of renewables' deployment in the country and to support communities in their protests against conventional energy projects. Interviewees of the environmental arena noted that their motivations for joining the opposition against the prevailing regime of conventional energy generators was founded primarily on environmental reasons, though equity and humanitarian issues were crucial part of their motivation as well. Among their advocacy activities were (see the list on Chapter 2, Section 2.4 on most salient protests and civil society events):

- They supported and helped organize local communities in their rejection of conventional energy projects, primarily on environmental grounds

- They developed research studies associated to renewables' deployment in the country
- They advocated for the implementation of renewable energy laws and regulations and strongly lobbied in favor of the cause. They often worked with parliamentarians to advance the use of clean energy, and in some instances also supported governmental proposals and joined government's efforts
- They continuously advocated before the government for renewables' deployment, sustainability principles and energy efficiency

With respect to the role that environmental NGOs have played over the years, a government official commented:

"I think environmental NGOs have pushed and demanded that generation of electricity shifts towards incorporating more sustainable characteristics, and that has put the topic [of sustainability] on the table, with some projects needing reformulation and improvement, and other being cancelled... and that has opened a path for doing more sustainable projects, as those of NCREs…", ***Government official****.*

Industry associations

Private sector entrepreneurs also started to see an opportunity in the electricity sector for the introduction of renewable energy technologies for electricity generation. The Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*, ACERA) was created in 2003 and was followed by the creation multiple other associations of the kind in the years to come. At the beginning, ACERA and the following ones did not have much capacity or power to exert a strong lobby for the development of the renewables sector, but as time passed and the debate around renewables gained visibility, they started to become much more involved and powerful. The following table (Table 3.1) details the year of emergence of NCRE industry associations from the NCRE sector.

Table 3.1. Emergence of NCRE industry associations.

Year	Industry Association
2003	Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*, ACERA)
2007	Chilean Association of Solar Energy (in Spanish *Asociación Chilena de Energía Solar*, ACESOL)
2008	Association of Small and Medium Size Hydroelectric Generation Plants (in Spanish *Asociación de Pequeñas y Medianas Centrales Hidroeléctricas*, APEMEC)
2009	Chilean Association of Geothermal Energy (in Spanish *Asociación Chilena de Energía Geotérmica*, ACHEGEO)
2015	Association of Marine Energy (in Spanish *Asociación Chilena de Energía Marina*, ADEMAR)

Industry associations supported actively the development of a market for renewables motivated by business interests (which they have identified extrapolating from international experience). They worked hard advocating in favor of the NCRE laws, proposing new regulations to the government, and publishing studies that backed the positive contribution of renewables to the Chilean energy sector. Some of these organizations, e.g. ACERA and the Association of Small and Medium Size Hydroelectric Generation Plants (in Spanish *Asociación de Pequeñas y Medianas Centrales Hidroeléctricas*, APEMEC), have been more active in terms of political lobbying than others, being the most relevant one in the sector ACERA, which represents renewable energy enterprises of all kinds in the sector and currently counts with around 120 members. Key actors of the NCRE sector include leaders such as Carlos Finat, Alfredo Solar, José Ignacio Escobar, Daniel Canales, Juan Francisco Mackenna and Pedro Matthei.

Working together for a common interest

Environmental NGOs and NCRE industry associations ended up joining forces in line of a common interest. In 2007, they allied and worked side by side lobbying before and then along with parliamentarians, and then even allying with the government for passing the first quota law that faced strong opposition from the group of conventional energy companies that dominated the market. On the government side, key actors include Christian Santana, Marcelo Tokman and Andrés Romero. The first quota law established a required percentage of the electricity generation mix to come from NCRE sources, which was to start being 5% in 2010 and incrementally augment up to 10% in 2024.

With respect to the relevance of environmental NGOs' support and lobby for the quota law approval, a government official expressed:

> *"…I think environmental organizations contributed decisively to generate a substantial public support for renewables, especially to wind and solar energy, and that obviously mobilizes parliamentarians… so I think that that support was crucial for the discussion of the quota laws and for installing in society a favorable and positive attitude towards the development of NCRE technologies…",* ***Government official.***

But the influence of social organizations did not stop there. Beyond their respective attempts for continuing to advance the sector according to their respective interests, they also organized joint initiatives for further discussing energy issues and advancing their shared claim. In 2009, along with other energy-sector stakeholders, they convened the working group *Escenarios 2030* (in English *Scenarios 2030*), an initiative that aimed to open a discussion space of different potential scenarios of energy and electricity generation for 2030, with the aim of generating insights for the elaboration of energy policy. The group was constituted by actors from environmental NGOs, from the public and private sectors, universities and the civil society. This group continued to operate until 2014.

In 2011, after the massive protests against the *Hidroaysén* mega proyect took place in May that year, environmental NGOs and industry associations along with some congress members convened another working group for discussing energy policy issues. The initiative was called Commission of Citizens, Technicians and Parlamentarians (in Spanish *Comisión Ciudadana Técnico Parlamentaria*, CCTP) and was formed in parallel to the Electric Development Advisory Commission (in Spanish *Comisión Asesora para el Desarrollo Eléctrico*, CADE) convened by the Chilean government for discussing and generating suggestions on energy policy matters. The CCTP commission included parliamentarians, environmental NGOs, professors and technicians, and gremial organizations in the renewable energy sector. The commission published an outcome document with a series of proposals entitled *"Chile needs a Great Energy Reform: Proposals for the transition towards an electricity development that is clean, secure, sustainable and fai*r".

In 2013, social organizations joined forces again to support a second quota law that attempted to augment the percentage requirement of the electricity mix coming from renewable energy sources.

This law was lead and proposed by a group of parliamentarians that were asking for 20% of the electricity mix coming from NCRE by 2020. The proposal again faced strong opposition on part of some members of the government in office (which had changed in 2010 to the right-wing coalition), but was finally approved enjoying strong congress support, though the percentage was finally augmented the 10% requirement previously established for 2024 to a 20% requirement to be reached in 2025.

The leader from one of the most active environmental NGOs in energy matters commented:

*"The legislative reforms in energy matters were a product of demands from the civil society and some parliamentarians. The government finally reformulated the legislations [in the first quota law], but it was a civil society's initiative, and then the second law was an initiative from a group of senators and civil society organizations…", **Director of environmental NGO**.*

More recently environmental NGOs and NCRE industry associations have naturally parted ways in terms of their objectives with respect to renewables. Now that basic goals have been achieved they find their differences more meaningful with respect to environmental requirements of projects and the development of large hydropower projects, among others. Environmental NGOs have recently become more involved in issues related to distributed generation and participatory planning in the sector, thus focusing more on issues that have a strong equity and democracy components. Another environmental NGO leader argued in this respect:

*"ACERA has always been very pro-establishment, while they are able to do their business they do not have a problem with the system, they do not criticize anything substantial or anything structural… but at the time we were strategic allies, as the system had too many barriers for the entrance of NCRE technologies…", **Director of environmental NGO 2**.*

On the other hand, NCRE industry associations have got more involved in the development of more technical regulations. An important milestone in the transition was the change in public tender regulations that the government passed in late 2014. This change concerned the public tenders for supplying electricity to distribution companies that serve regulated costumers, which represent approximately 55% of the market. Public tenders used to be assigned based in blocks of constant amounts of power, which did not allow intermittent energy sources, such as solar and wind energies, to participate. The renewables' private sector led by ACERA started to suggest a change in the regulation that involved tenders structured around energy blocks (instead of power blocks) for allowing renewables to enter that market. In 2014, they suggested the change to the Minister, who heard the demand and ended up rapidly implementing the change. With respect to ACERA's involvement in policy-design processes and its interaction with the government, interviewees commented:

> *"the industry association of renewable energy ACERA has done a great job not only in terms of information about NCREs, but has actively participated in the design of public policies, along with other industry associations in the sector, and I think they have been an important stakeholder, that has been able to organize as an institution and even develop studies to show under which conditions the NCREs were able to join in the electricity system",* ***Government official***.

> *"as the [NCRE] private sector we associated through ACERA, aligned objectives and talked to the government, and the government welcomed our demands and implemented reforms without promoting any specific technology, and I think we gained with that that all the education and thrust building process on renewables was quicker",* ***Director of the Renewable Energy Association.***

This achievement is of remarkable importance as it not only allowed renewables to reach a huge market, but it also enabled them to get access to Power Purchase Agreements (PPAs), something that financial institutions had lately started to require and was becoming a huge problem for developers in the sector. Notably, as was mentioned in Chapter 2, the change in public tender regulations had caused a consistent and significant drop in energy prices as a result of the increase in competition and the entrance of price-competitive NCRE technologies to the market.

Both environmental NGOs and NCRE industry associations continue to be actively involved in the energy sector. Recently in 2015, when the government convened working groups for elaborating the new energy policy *Energy 2050*, representatives from both groups were convened as relevant stakeholders in the sector. Only few environmental NGOs joined the initiative, as the rest have reservations with respect to participation issues and their agency capacity. This does not mean though that they have marginalized themselves from the debate; they have continued to engage in the political debates through other mechanisms, while making the statement that they do not legitimize the policy design process. On the other side, NCRE industry associations joined the group more enthusiastically, as they seem to be satisfied with the improvements that have been achieved in the sector and with their work in partnership with the government, and thus have more positive expectations about their future cooperative work.

Evidence seems to indicate that both environmental NGOs and NCRE industry associations played a crucial role in placing and advancing renewables' matters in the political agenda. They have also worked by themselves and joined forces for opening up a market for renewables in the country and afterwards for consolidating it. Moreover, their constant political lobbying seems to have contributed to effectively drive the Chilean transition in their desired direction by specifically putting pressure in the established regime of the electricity sector forcing a change to happen.

3.3.2. Socio-environmental conflicts and social movements

Environmental NGOs and NCRE industry associations did not affect the transition alone. In the front line against the prevailing energy regime dominated by conventional generation projects along with them were local communities, indigenous communities and the civil society in general.

After the gas crisis erupted in Chile by 2004, the private sector privileged the development of coal power plants. Several huge projects were built in Northern Chile as well as in the south of the country. Coal was seen to be the cheapest and most convenient solution by the private sector at the time (remember that the Chilean government does not have a planning strategy neither with a land-use policy that organize the electricity generation sector, so technically any generation project that meet existent environmental and some other regulations can be developed). The electricity sector grew based on carbon from 2005 to 2010, meeting much less strict than today's environmental requirements.

With the scheduling and development of coal and large scale hydro-power projects, several conflicts with communities and the civil society started to erupt around 2005 and 2006. Problems reported huge pollution scandals due to emissions and industrial residuals related to coal-based electricity generation. By the time, local communities, including citizens and local authorities, started to oppose massively to the development of coal generation projects in their territories, especially in the northern part of the country. Along with that, strong opposition to large hydroelectric generation projects re-emerged, especially with the announcement of the *Hidroaysén* mega-project planned to be built in the Chilean Patagonia region. (For a more detailed list of events see Chapter 2, Section 2.4.)

Figure 3.1 shows the evolution of socio-environmental conflicts associated to electricity projects. The time period between 2005 and 2010 was characterized by the appearance of mostly large scale conventional energy generation projects, with almost all of them facing socio-environmental conflicts (rejection from local communities and massive protests). After that, the years following 2010 were characterized by the proliferation of several small scale renewable energy generation projects, with only a few of them facing environmental-conflicts. From the figure it is possible the contrast between conventional and NCRE technologies with respect to socio-environmental conflicts.

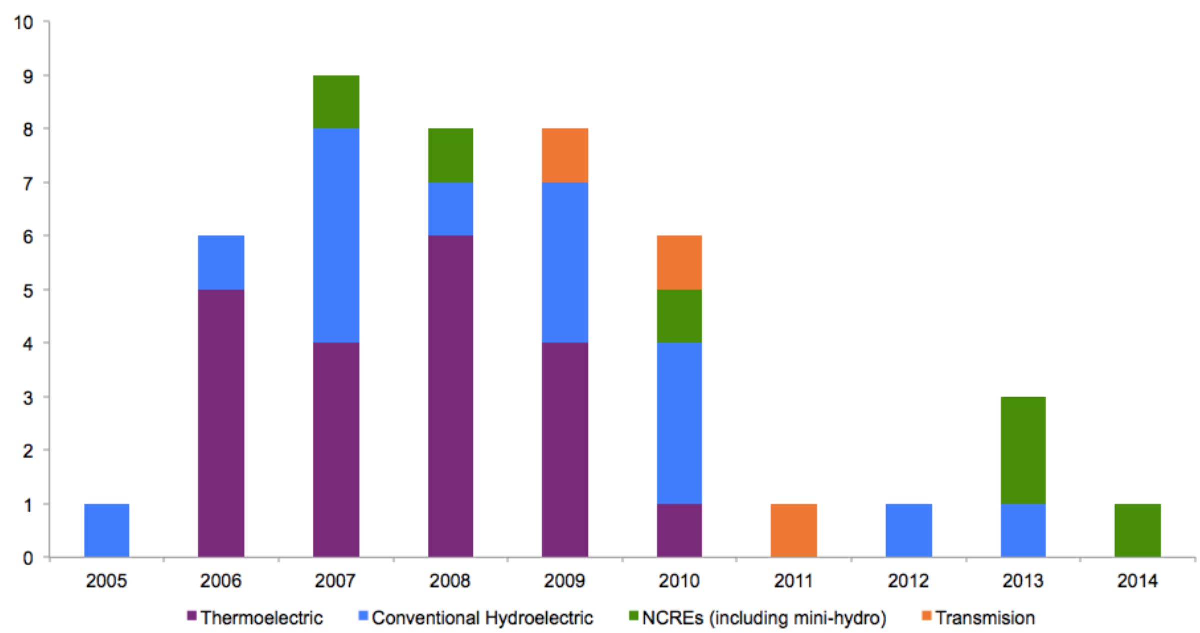


Figure 3.1. Evolution of socio-environmental conflicts associated to electricity projects.
Data source: INDH (2015).

<u>Massive protests: emblematic cases</u>

There were certain emblematic conflicts that raised particularly massive opposition on part of local communities, the Chilean civil society and the international community.

Perhaps the most emblematic of the socio-environmental conflicts that have taken place in Chile is the one around the *Hidroaysén* project that started in 2005. The counter-campaign *Patagonia Sin Represas* (in English "Patagonia without dams") begun to operate in 2007. In 2011, there were massive protests at a national level against the enterprise. The project received environmental approval, but the Committee of Ministers discarded it in 2014 (the right-wing government has postponed the decision finally leaving it to the left-wing government that assumed office in 2014). Finally in January 2015, the companies developing the project announced that they will not continue with it. The director of one of the leader environmental NGOs of the counter-campaign commented:

> *"We made a well-founded campaign with knowledge fundamentals arguing that there were other ways to generate electricity with much smaller impacts, referring to NCREs and energy efficiency… and we helped to raise awareness, we did a very aggressive environmental education campaign, we created advertisements and put them in the media and in the newspapers, we gathered the resources to do press inserts, and with that we educated citizens by giving arguments that allowed them to understand that what was being told [about the indispensability of HidroAysén] was not such, and that there were other ways to do things... […] we built a campaign with a strong component of citizen education, giving people arguments using simple language…", **Director of environmental NGO**.*

Another very controversial conflict was the one around the thermoelectric power plant *Barrancones*, that started in 2008, and involved the construction of a coal plant for electricity generation in a national reserve in a coastal zone in the north of Chile. Though the project got environmental approval in 2010, President Sebastian Piñera himself decided to call it off.

There was another particularly important conflict around the *Castilla* coal-based thermoelectric plant that started in 2009, which it is still not completely over. The project intended to build the greatest coal power plant in Latin America, to be installed in the Northern region of the country, in an area where fisherman and inhabitants think it will prejudice fishing and people's quality of life. The project got environmental approval but in 2012 the Chilean Supreme Court ruled against its construction.

As a result of the massive public opposition that conventional energy projects triggered, they started to face long-lead times due to environmental concerns and the process of getting environmental approval from the Ministry of the Environment to move forward. This massive opposition to large-mega projects many times led to legal disputes (called "judicialization" in Chile, in Spanish "*judicialización*"), with the projects eventually left undeveloped in many emblematic cases (such as the aforementioned *Hidroaysén*, *Castilla* and *Barrancones*) due to a Supreme Court's ruling or even a governmental decision of discontinuing them. The stop of several mega-projects left a portion of the projected electricity demand unsatisfied, offering an opportunity for the development of alternative energy technologies.

Speaking about the incidence of social opposition movements in the transition to renewables a government official commented:

*"I think environmental NGOs were permanently advocating for the introduction of renewable energy… […] they were promoters of the implementation of NCRE policies… […] and [also] by blocking the development of conventional energy projects, they contributed to the high energy prices and with that to the necessity of implementing the alternatives that could prosper…", **Government Official**.*

<u>Underlying motivations of the opposition</u>

Communities across Chile opposed conventional projects for a multiplicity of reasons. The most visible one was environmental, but others include equity problems, lack of participation and of a democratic approach in the design process of projects, and fear to new and unknown technologies. Indigenous communities from the southern region also had territorial and religious reasons for opposing the projects, denouncing that they flooded their territory and sacred sites. It is important to mention that the conflict with indigenous communities in the south transcends the electricity generation domain; it is corresponds to a long standing conflict with the state of Chile that spans to political, territorial and governance aspects over disputed territories in the Southern region. Importantly, as Chile joined the OECD in 2010, the country acquired the commitment of consulting indigenous communities for developing projects in the lands where they live. This was established in the Indigenous and Tribal Peoples Convention, in 1989, and referred to as ILO Convention 169 (in Spanish OIT 169). In addition to that, leaders of the environmental movements that I spoke with, think people are increasingly developing an environmental conscience, it is also that they disagree with anti-democratic practices that the conventional electricity sector was used to when (unilaterally) developing their projects. People perceive as unfair that business do not share their revenues with local communities that often bear the negative externality costs of generation projects, and they do not like the fact that the Chilean government completely lacks a land-use plan for organizing the use of the territory.

International support

Many of the massive social movements received support from international NGOs in the form of direct financial resources, intellectual and professional capacity, communication resources, among others. Particularly active international environmental NGOs in energy issues were NRDC, Greenpeace Chile and the WWF. NRDC, for example, supported the financing and development of studies for the *Patagonia Sin Represas* campaign, which also received funds from the Tides Foundation and the International Rivers. As another example, Greenpeace did not support with much financial resources such campaign, but they offered professional and intellectual capacity, and worked making campaigns visible internationally.

Opposition to NCRE projects

There were also a couple of cases in which NCRE projects faced important opposition as showed in Figure 3.1, though in general they did not have to deal with such great opposition on part of communities and the general public (Finat, 2015). An emblematic conflict that involved the development of a NCRE power plant was the case of the wind farm project *Parque Eólico Chiloé*, that erupted in 2010. The plant was planned to be installed in the Chiloé island in Southern Chile. It was planned to be built in the beach of *Mar Brava*, in an area where people fear it might affect tourism or the great biodiversity of the site, and which is also an important archaeological site for indigenous communities that inhabit the site. The conflict around the project is still latent, and the case is often cited as proof for arguing that Chilean local and indigenous communities oppose any kind of electricity generation technology and that their argument is not based on environmental reasons. Indeed, some experts have argued that the population is suffering from a NIMBY syndrome, and just oppose any project that gets planned in their surroundings. The truth is that this project planning process had multiple flaws, especially with respect to environmental studies and communities' consultation, as confirmed by some of the interviewees (confidential sources).

The CEO of a NCRE company expressed with respect to the attitudes of communities towards NCREs:

> *"I think renewables have the opportunity of being by nature good co-habitants with communities if you start working in advance along with them… we still have a lot to learn, but communities never oppose to renewable energy technologies per se, they might oppose to a specific type of project or to the way in which the project is being developed, but people understand that renewables are the future and that they will need to learn to live with them, but that is not the case with fossil fuels, as they are intrinsically against those types of technologies…",* ***CEO, NCRE private sector.***

Even though it is true that renewable energy projects have so far faced considerably less opposition on part of local communities, they have started to arise much more concerns in recent years given the rapid proliferation of projects. This is particularly the case in the north of the country, were multiple solar installments have been developed in the Atacama Desert. Even environmental NGOs have started to get concerned around the issue, though no visible manifestation of that has called much attention so far. With all, the future development of the sector certainly depends on the ability of developers and the government to work around the relationship with communities.

An additional problem that has emerged in recent years is the threat of legal action on part of lawyers and community leaders that approach communities encouraging them to file claims with questionable motives in order to obtain monetary compensation from projects. Of course this implies stopping projects' development for long time periods, even in cases when projects have already been developed in good relationship with the local communities, as confirmed by some interviewees.

3.3.3. Opposition from conventional energy companies and parliament support

The rise of opposition from the traditional energy sector was severe when the rules of the game in the electricity market started to be evaluated and re-thought. When the government drafted the first quota law around 2007, the final version decided that generation companies were going to be required to provide a certain percentage of the electricity they generated from NCRE sources. Of course this caused a negative reaction on the conventional sector that dominated the electricity generation sector, as they were the ones ending up worse-off after the measure was to be implemented. The three big generation companies that dominated the market at the time lobbied strongly against the law approval. They sustained their argument claiming that new NCRE technologies were expensive ones, that they were going to make energy prices to rise, and that Chile was not in a position to afford subsidizing the development of such technologies when its carbon emissions were less than 2% of the world's. In the parliament the opposition (to the quota law) was composed mostly by conservative think-tanks and associated congress people, by right-wing parliamentarians that constantly opposed any type of market intervention on part of the state, and by those who truly feared for the energy future of the country if these knew unknown technologies were to be implemented.

Meanwhile, the renewable energy quota law was supported by a wide coalition. The law was developed by the National Energy Commission that was the government's institution in charge of the energy sector at the time. Besides the government, the law was actively supported by environmental NGOs on environmental grounds, and by NCRE industry associations from the renewables' sector motivated by businesses' interests. Despite all the opposition and lobby that the first quota law had to face, congress finally supported it massively and the bill was passed in 2008 with no votes against (just a couple of abstentions due to conflicts of interest). According to the interviewees, people from the parliament supported the bill on environmental grounds, as well as driven by ethical and equity considerations. Policy-makers at the time think also that the parliament in general was aware of the energy crisis that the country was facing. These reasons coupled with the massive opposition that communities were presenting to the development of conventional energy projects at the time.

In 2013, the second quota law, this time proposed by parliamentarians, faced similar opposition than the first one. This time the law attempted to increase the percentage requirement of the electricity mix coming from NCRE imposed to big generators. Again the traditional energy sector argued strongly against setting a much more ambitious target, and was again supported by some members of the government in office which at the time had changed shifting from a moderate-leftist coalition to one much more right-wing. The arguments this time stood around the intermittence of NCRE technologies and the technical unfeasibility of the system to bear an important percent of electricity coming from them due to that. Importantly, this time incumbent companies were represented by the Association of Chilean Generation Companies (which groups all the big electricity generation companies above 200 MW), the industry association that they had created in 2011, when realizing the need for having a unified voice that represented them. Supporters of the new quota bill included parliamentarians, environmental NGOs, NCRE industry associations, experts, and politicians from the previous government coalition (that constituted the opposition at the time). Though the ambitious target of 25% by 2025 that parliamentarians and social organizations were requesting was not finally established (they were asking for 20% of the electricity mix coming from NCRE by 2020), the law (Nº 20.698) was passed and the goal was augmented from the 10% requirement previously established for 2024 to a 20% requirement to be reached in 2025 (the incremental percentages were consequently modified). The initiative again enjoyed strong congress support and was approved almost unanimously. It is important to mention that while for the approval of the first quota law positive expectations were key, for the second law support came in great part from the successful pilot projects that had been implemented in the country, which set further positive expectations for the future.

Speaking about the reason for parliamentarian support to renewables, the director of an environmental NGO expressed:

"because they are closer to the people, they are in their districts… […] They might not be technicians, but they realize that the rest of the world is implementing other types of energy technologies, and they also know about climate change, so how can you possibly continue to build thermoelectric power plants! […] of course the parliament has a higher social control, because their voters are there, and they see them, and they know about these issues…", ***Director of environmental NGO***.

Beyond the explicit debates for the two laws in the parliament, the NCRE sector still experiences constant hurdles on part of the conventional sector. Up to date, they continue to resist changes in regulations and policies that aim to facilitate the development of the renewables' sector. Speaking about that, the Executive Director of ACERA commented:

"we perceive that until today there are still intentions for maintaining barriers to renewables… […] the fight is not over, at the CDECs when normative changes are discussed, immediately they raise requirements that many times do not even affect them, but do prejudice the renewables' sector", ***Executive representative of the Renewable Energy Association.***

With all, the traditional sector has experienced a change on attitude during the years, as the transition has moved forward. Many of the big generation companies have started to invest in the renewables' sector and organize their own tenders for NCRE technologies. When talking with a high-level executive from the incumbent sector, he expressed:

"…I think these technologies came to stay and that they are out there, and they are welcomed…", ***High-raking conventional private sector executive***.

It seems that the focus of their battles have changed. They are not much focused anymore on resisting a regime change, but rather want large-hydropower to be recognized as a renewable energy technology (getting rid of the term NCRE), and want to encourage remunerations for service quality and reliability, as well as the development of a market for ancillary services.

3.3.4. Participation and legitimacy

The social factor of the Chilean electricity transition carried out positive side effects along the way. One of the most relevant ones is the increase in the participation character of public and private activities. They directly impacted the way in which the government develops policy as well as the way in which the private sector develops generation projects.

Energy policy-making

After the massive opposition and mobilization that electricity generation projects aroused for environmental, territorial, democratic and equity reasons, and with the private sector demanding help for advancing their projects, the government had no other option than start incorporating a social component in policies and plans. This is how the way in which energy policy and planning in the sector evolved towards reflecting a much more participatory approach. In this respect, two interviewees expressed:

*"the two controversies of HidroAysén and Castilla where big moments for the public discussion on energy… […] from that moment on is that all this social twist of the Ministry of Energy starts… before that the social aspect did not have any room in the Ministry, or if so a very tiny one.", **Expert, University Professor.***

*"... environmental groups have set the tone. Thanks to them, the government, the public sector, parliamentarians, even the judiciary, have realized that both public policies and projects need to be developed with greater participation, a participation with agency that generates a preferable direction for projects, better approval rates, and not by force, but because they are designed in a better way… I think it is fundamental that the civil society maintains this critical role…", **Government official.***

When the current political coalition assumed office in 2014, the Ministry of Energy decided to create a participation unit, as a way to help handling the social issues that affected the development of the sector. The unit has already gained more prominence changing its status to one of the seven divisions of the ministry, which cover all the spectrum of issues that the ministry governs. For now, the participation division focuses on opening spaces for facilitating the dialogue between private sector enterprises and local communities, conversations that today are almost limited to help talking and negotiating about the location where the new power plants are to be installed. But the division has more ambitious objectives and aims to work for advancing participation and deliberation with communities, for the creation of a land-use policy, and is also making efforts to work with indigenous communities helping to handle their special situation and needs.

In the same vein, when the new *Energy 2050* policy was designed, the government made efforts for trying to develop it through a democratic process that gave it legitimacy. Indeed, the Minister of

Energy Maximo Pacheco said in an interview in 2014 "When there are no institutional channels, people end up expressing their opinions in other ways: through the courts, on the streets, etc. In order for us to have a successful energy strategy we need to socially validate it. [...] Chile's future growth depends upon regaining people's trust to deal with these matters in the most adequate way possible" (Turner, 2014). The policy design process included spaces for dialogue with stakeholders in all regions of the country, as well as meetings with committees of experts, a leading group that tried to include stakeholders from all sectors, and even observing researchers that analyzed the governance process of the policy. The design process received many critiques from different stakeholders, with many of them abstaining from participating as they did not think to have a real power to influence outcomes that were thought to be decided almost in advance. The policy was criticized for its centralized nature and for not being a product of a truly deliberative process, especially questioning the agency capacity of stakeholders. The truth is that, though wide working groups participated in the process, final decisions were indeed made by a group of government officials from the ministry of energy with the excuse that the government may reserve itself the right of making final policy decisions. A university professor that studies the topic commented in this respect:

*"in practice, participation is still limited to very specific moments, with very homogeneous people, and where any noise is blocked or wiped out of the study, […], that is the case of the Energy 2050 policy process, where possibilities for the future were pre-defined by the same group of few policy-makers, experts and private companies that have defined energy policy in this country during last 20 years…", **Expert, University Professor**.*

With all, everybody recognize and value the progress and effort that the government has made in terms of advancing participation in energy policy-making, which has arguably started to set a precedent in the energy sector and in the governmental sphere in general. A government official commented:

*"I think the civil society has had a main role in Chile, not only for the development of renewable energy, but also for the way in which we develop energy policy in Chile in general", **Government official.***

"We see that it begins to leave a mark, and also it is said that there is already pressure for other ministries to begin to incorporate some of the strategies we are implementing… but we are also innovating and then we see that some things work while other things do not... In the early stages projects become slower to develop, but in the long run they become faster because they move forward with a faster pace. In the early stages they are more expensive to develop because we have to incorporate social sciences that were not incorporated before, but in the long run they become cheaper because you save a lot...", ***Government official.***

Business development

The private sector has also experienced a change in the way they develop projects in the sector. Due to the massive opposition and rejection to projects, they have been forced to change their old unilateral design strategy that now needs to include a social vein in order to be able to move forward with their ventures.

The NCRE sector has particularly taken advantage of this, and started early to incorporate a social dimension in their project development phases, including activities like early contact and meetings with local communities, establishing business partnerships with them and educating people on the technologies to be installed. The conventional sector, more used to their old business strategy, has slowly started to follow the new approach just recently realizing that there was no other way to move forward. As a matter of fact, NCRE sector executives identified the social twist in the classic business approach as one of the top reasons why they have been able to rapidly develop their projects. In that sense, the social dimension that NCRE projects have adopted and the lower environmental impacts associated to them have been key features that have greatly enabled the transition to move forward.

The following are quotes from interviewees with respect to how the way of doing business in the sector has changed over the years:

"... the mindset of the electricity sector has changed… […] we approach the communities in a different way, trying to understand what they need and to incorporate them on early stages of project development… and then since we came "dressed in green" they immediately open the door…", ***NCRE private sector executive.***

"our business model has been to develop proyects along with communities… […] We have grown thanks to this model twice as fast than other developers. With the community in your favor, the approval of environmental and other studie is way quicker.", ***CEO, NCRE private sector.***

"Among the relevant factors for developing a successful project, the relationship with communities is first on the list. Today, projects have to be developed taking into account the local development, that is to say one can not build a generation project [without considering] neighboring communities. That, which was perhaps common practice until recently is already part of history, today we are immersed in a community and that implies watching over for the integral development of that community… these projects are innately small, but to the possible extent, we think that collective effort adds up and translates into changes in the quality of life of people. I know stories about very small projects that have radically improved the quality of life of isolated communities, in terms of transportation, communications, basic services, connectivity in general, opportunities, etc. Because is not that we only create some jobs, actually we create several temporary jobs but not as many permanent ones, but are also catalysts of a number of other benefits.", ***CEO, NCRE private sector****.*

"the rationale has changed… sustainability became from being something outsourced to be in the top of management… […] and the communities-issue is also now in the top of management… this has happened since the main hurdle for moving forward with projects were social issues… now the way in which the top of management approaches projects is radically different… […] it represents a new vision for doing projects", ***High-raking conventional private sector executive.***

Future challenges

Despite the valuable progress in terms of participation principles and legitimacy, there is still a long way to go. An urgent necessity demanded by the private sector is the establishment of some regulation for dealing with communities when developing energy-related projects. The government has tried to develop some guidelines for the development of projects in a more participatory way, but the private sector still perceives that there is a latent need for defining clear limits and obligations for each of the involved parties.

In relation to the above, there seems to be an urgent need pointed out by social organizations, mostly NGOs and scholars, of developing a clear land-use policy for the country. Currently, the energy generation sector completely lacks such regulation, and generation companies are virtually able of locate their installments anywhere, if environmental requirements are met and the necessary permits are obtained. This type of almost unilateral decisions upset local communities that not only feel marginalized from decision-making spheres but are also unwilling to bear the negative externalities of projects in exchange for no benefit, and then rush to organize and raise opposition to stop projects. The new transmission law starts to deal with this issue as it assigns the government with the role of defining territorial sectors where transmission lines and associated infrastructure might be located, but overall the development of a well-defined land-use policy for the Chilean territory is a pending task.

An additional negative side effect of the social opposition that has taken place in the last decades is the “demonization” of hydropower electricity generation in general. Putting aside the debate of whether large-scale hydropower is sustainable or not, small hydropower generation like run-of-river power plants are generally accepted as a sustainable way of generating electricity (when meeting appropriate environmental requirements) (see McCrone et al., 2016), and this is why Chilean environmentalists accepted the inclusion of this type of electricity generation in the definition of NCRE sources in the Chilean law (see Short Act I). But in Chile, especially in the southern zones of the country, communities are generally not aware of the existence of different types and scales of hydropower plants, and then oppose any kind of hydro-based generation project. Thus, small hydropower developers in general struggle a great deal for explaining their projects (independently of its characteristics), and negotiations and mediations are many times unfruitful. In that sense, there is a special need for educating communities with respect to the diverse types and benefits of different hydropower technologies.

3.4. Analyzing the politics of the Chilean transition

In the previous section I identified important actors that played out significant roles in the political process of the Chilean electricity transition. In this section I present my interpretation of the politics of the policy process, identifying now the political roles that each of the involved actors played in the process of policy change.

3.4.1. Social organizations as policy entrepreneurs

The role played by both environmental NGOs and industry associations (ACERA, in particular) exhibits characteristics of the role that policy theorists assign to policy entrepreneurs. I argue here that such social organizations can be seen as the policy entrepreneurs of the Chilean transition process. As discussed previously, policy entrepreneurs are the responsible ones for introducing alternative policy ideas into the political arena and working tenaciously for turning them into policy. For doing that, they often take advantage of the window of opportunity that a crisis event opens up when highlighting the failures of existent policy arrangements.

It is worth noting here that despite the fact that policy entrepreneurs are most commonly identified as individuals in the literature, in this manuscript I characterize and treat them as organizations. This has been done in other works such as Hermansen's (2015) analysis of the role of certain Norwegian NGOs that acted as policy entrepreneurs fostering the establishment in record time of the world's largest donor-side REDD+ initiative in 2007, and is also in line with Huitema et al.'s (2011) idea that individuals contribute to transitions in collectives, dividing tasks over various members. The decision of identifying certain organizations as entrepreneurs was motivated by the fact that interviewees mostly described entrepreneurial actions (either their own or others') characterizing their role and incidence in the transition as part of groups and coalitions that worked and made achievements supported by numerous teams instead of putting emphasis in their role as individual leaders. In addition, treating entrepreneurs as organizations offers some room for error in case interviewees forgot to mention someone, and allows for the recognition of the role of the subsequent leaders in the involved organizations across the years. Despite this consideration, it is always true that groups are formed by individuals, and this is why the most relevant actors pointed out by interviewees have been mentioned in section 3.3.1.

Back in the early 2000s, when no one was talking about renewable energy in Chile, environmental NGOs started to push the topic onto the political debate. As mentioned before, in 2003 activists and environmental NGOs drafted a law proposal that seek to foster renewables' deployment through subsidies, but the initiative was mostly unsuccessful. With all, they did find some support among parliamentarians at the time, and started building a network of supporters.

Around 2003, with the creation of the Chilean renewable energy developers association ACERA, the key group of policy entrepreneurs from industry associations started to enter the energy political arena. At the beginning, ACERA did not hold much power but as time passed by other renewable industry associations where formed, and ACERA in particular has become one of the most active and powerful constituents in the sector.

When the Argentinian gas crisis that hit Chile in 2004 (whose impacts started to be felt around 2006), environmental NGOs and renewables industry interests (represented by ACERA) where able to identify the opportunity and to work hardly to take advantage of it, promoting renewables as a viable solution for the crises the country was facing ("policy marketers"). The gas crisis event is indeed identified as a key event that marked a before an after in Chile's electricity history. One of the directors of a very active environmental NGO commented:

"…it would have never been possible to open a path for renewables if it weren't for the gas crisis with Argentina, this was the political opportunity that was seized…. before that, the National Energy Commission had a future project plan that contemplated 9 combined-cycle generation plants, one large hydropower plant, and the rest was all reliant onto natural gas. If we had not had the crisis, there would have been no space for talks about alternatives.", ***Director of environmental NGO***.

The occurrence of this crisis event opening up an opportunity for policy change coincides with policy entrepreneurship theory. Hay (1999) argues that in order for policy entrepreneurs to challenge existing arrangements, a crisis and policy failure must be identified and widely perceived. Once a crisis is identified, the failure of a prevailing policy paradigm drives policymakers to look outside government for a solution (Oliver and Pemberton 2004).

In part because of social organizations' constant push, the government started to seriously consider the option of renewables as a real alternative energy source that could represent a solution to the lack of fossil fuels. The National Energy Commission at the time started to study the option of renewables concluding that they were a viable option and that future expectations were promising. The government then decided to design a policy project (first quota law) that would open the market for renewables' entrance. The government team that researched the options of renewables and decided to put together the policy project can also be considered a group of policy entrepreneurs that worked for renewables' deployment temporarily (for the purposes of passing the first quota law).

When the political debate around renewables eventually flamed up within the discussions of the first quota law in the parliament, environmental NGOs and ACERA, realizing its intersecting objectives, rapidly joined forces forming a advocacy coalition that continued to fight for renewables until recent years (will be further described below).

Social organizations were then not only able to push the topic onto the political agenda but they managed to keep it there. Speaking about the role of these organizations in the transition, two government officials commented:

"Environmental NGOs and the civil society in general played a fundamental role in putting on the table and on the political agenda the issue of NCREs… the transition then was in part a product of] the clear vision of certain actors about the necessity of integrating more strongly these energy sources to the energy mix… […] I think environmental NGOs worked for many years focused in the development of NCRE sources", ***Government official.***

"ACERA and all the industry associations that emerged along the way were also key for encouraging and forcing the government to adopt a stronger and clearer vision [with respect to renewables]…", ***Government official****.*

Environmental NGOs and industry associations participated actively in the policy formulation process of the NCRE law (as well as in the decision-making stage of it in the parliament, this aspect of their role will be addressed below). After the first quota law was finally approved, they continued to be actively involved in policy formulation processes. Together and in their own respective capacities, they developed several research studies covering topics such as the renewable energy potential of the country and on the potential impact of the integration of renewable energy sources. They also joined several working groups that discussed energy policy issues, some of them organized by the government and others convened by themselves for discussing energy policy issues, such as *Escenarios 2030* or the CCTP commission that was parallel to a commission designated by the government for discussing proposals on energy matters (CADE).

As the renewables' sector evolved over time, Environmental NGOs and industry associations continued to actively work for renewables' deployment. They have participated in the legislation debates about energy issues, with environmental NGOs now focusing their work on equity aspects, while industry associations focusing efforts in working with the government for the development of technical regulations.

It is relevant to recognize the international influence that shaped entrepreneurs' positions and possibilities. Indeed, most of the knowledge that motivated Chilean policy entrepreneurs' claims (of both environmental NGOs and NCRE industry associations) came from abroad, in terms of both environmental science and policy. At the same time, international support from international NGOs was also crucial for boosting the campaigns they led to reject conventional energy technologies and support NCRE generation.

Before switching to the next section it is worth make a clarification. The reader may consider the option of renewables as the natural solution to Chile's lack of fossil fuel resources, which would imply that the transition to renewables would have been an expected path to follow. This was not the case in Chile though, as it gets demonstrated by the fact that incumbent companies were interested in developing more coal thermoelectric plants and big dams as a response to the energy crisis, and did not manifest any interest in the renewables' sector and even raised opposition to the quota initiatives. While some government officials recognized a strategic opportunity in the NCRE sector, environmental NGOs and NCRE industry associations are widely noted by interviewees as the ones that put the topic on the political agenda and that exerted the necessary lobby for pushing regulatory changes. With all, interviewees from the renewable's private sector believe that renewables might have entered the Chilean market in any case given the good conditions that the country has to offer —especially the quality of renewable energy resources and high energy prices—, but they also think that in that case they might have entered in a much slower pace, and probably without the reach and depth that has characterized the transition so far.

3.4.2. Overcoming regime resistance by means of advocacy coalitions

Advocacy coalitions

Berman (1998) notes that ideas then enter the political arena through particular actors who promote them and build supporting coalitions. Mintrom and Norman (2009) add to that that the composition and size of entrepreneurial networks (coalitions) can demonstrate the support for an idea.

In the Chilean transition case, environmental NGOs and industry associations not only were able to push the issue of renewables onto the agenda and were constantly participating in policy formulation processes, they also worked intensively in building coalitions that supported the issue and were able to push it forward.

When the debate over renewables reached decision-making stages (parliament) at the regime level, environmental NGOs and business associations started joining forces. As mentioned previously, for the discussion about the first quota law they joined the government side, but demanded a higher percentage of renewables' penetration than the one that government representatives were proposing. Indeed, social organizations were pivotal in the lobbying and arguing for the renewables' law, as can be observed from the "History of the Law" document.

One of the leaders of the environmental world pointed out the crucial relevance that joining forces with renewable industry associations represented for the transition. She argued that integrating private sector organizations to the movement changed its face and perception importantly, as they were not any more accused to be "radical environmentalists" pushing for a claim, but were seen as a much more balanced movement.

"…it was critical to establish and Alliance with ACERA, because with that we acquired the capacity of doing contraposition studies, because we [environmental NGOs] have resources for doing renewable energy potential studies, but we do not have the financial capacity, neither the necessary information to do more advanced economic studies, neither did the states, because in Chile the private sector is the one that owns the information. The alliance was also important in the sense that we acquired a private sector partner, with low media visibility, but at least we were not any more "the environmentalists" alone!", ***Director of environmental NGO***.

The green coalition story is much in line with the "bootleggers and Baptists" concept proposed by the regulatory economist Bruce Yandle (1983). The term is used to identify a coalition of actors with divergent interests that ally in order to gain the acceptance of a policy proposal. The analogy is derived from Yandle's observation that both Baptists and bootleggers favor regulations on alcohol; the former for religious or moral reasons, the latter because of the profit they can make selling illegal liquor. This implies that regulations are likely to be supported both by groups that want the ostensible purpose of the regulation, and by groups that profit from undermining that purpose. In their article

Simmons et al. (2011) argue that the “bootleggers and Baptists” model provides an adequate framework for considering how political entrepreneurs operate in the rent-seeking society.

This type of strategic action is in line with policy entrepreneurship theory that indicates that policy entrepreneurs need to be able to recognize the importance of developing and working with coalitions to promote policy change (Mintrom & Vergari, 1996). Moreover, theory indicates that the size of a coalition can be crucial for demonstrating the degree of support that a proposal for policy change enjoys, and that, the composition of a coalition can convey the breadth of support for a proposal (Mintrom and Norman, 2009). This is why policy entrepreneurs often work to gain support from groups that might appear as unlikely allies for a cause (Ibid.). Indeed, Baumgartner and Jones (1993) note that used effectively, the composition of a coalition can help to deflect the arguments of opponents of change, as it happened in the Chilean case.

After the first law was passed, environmental NGOs and industry associations maintained their alliance around their common cause (without the government, though). They continued mobilizing resources and helping to build a stronger coalition. As mentioned before, one of the big constituents of the renewables’ coalition was the adherence of local communities that opposed conventional generation projects, as well as the big portion of Chilean civil society that supported their claims, all with a diversity of reasons but under the visible umbrella of environmental motives. In the meantime, when multiple renewables’ industry associations emerged representing technology-specific interests, the renewables’ sector coalition became further stronger.

Environmental NGOs were particularly active in supporting communities’ opposition to conventional energy projects when pollution scandals arose. Furthermore, they coordinated and helped to organize the most salient protests that took place between 2008 and 2012 mostly building alliances with local communities and organizations. The most salient conflicts received support from international organizations, especially in terms of funding, professional capacity and communicational resources.

Social organizations continued to work for renewables’ deployment. They convened working groups to discuss energy policy matters (CCTP commission and *Escenarios 2030*), and pushed along with parliamentarians for the approval of the second quota law in 2013. After that though, they started to part ways realizing the fundamental differences in their motivations.

The Chilean case confirms the relevance of policy entrepreneurs that policy theorists propose in terms of coalition building. Theory indicates that policy entrepreneurs need to be able to mobilize resources (e.g. financial, professional) and form coalitions at a large scale in order to countervail the resistance that incumbent policy regimes exert. The role played by policy entrepreneurs as coalition builders is then crucial for the successful development of transitions, which is particularly relevant in countries where strong advocacy coalitions did not exist before as it was the case of Chile.

Resistance from the regime

As it was expected, the incumbent regime exerted huge opposition when the idea of implementing a quota law firstly emerged, and they continued to oppose against further changes as the transition evolved. As Hess (2014) describes, incumbent regime actors mobilize when policies are perceived to threaten their short-term profitability and long-term existence. The quota law was precisely imposing a requirement to them that did not existed before. In line with what Hess (2014) argues, in the Chilean case the conventional energy coalition was also supported by right-wing think tanks and conservative party politicians, who often oppose to any market intervention on ideological grounds.

After the first quota law was approved, opposition from incumbent companies continued and became strong again when the second quota law appeared in the political agenda. When there was no formal political arena for the debate, they continued to campaign through the media. They used communication resources (e.g. slogans, public propaganda, newspapers declarations) and the so called *campañas del terror* (scare campaigns) for trying to advance their conventional energy projects. Such campaigns included statements of electricity scarcity in the country and its terrible consequences, as well as arguments against the use of renewables that attempted to highlight certain advantages of large-scale conventional energy technologies. A couple of interviewees remember huge advertisements in (right-wing) newspapers with, for example, 2 entire pages covered with wind turbines to illustrate the amount of wind generators that were going to be needed to install the same capacity of one dam, or an alarming propaganda that argued that if (big) energy projects were not developed in the country even in the National Stadium (in Spanish *Estadio Nacional*) power would be shut down. Moreover, to date renewable energy developers continue to perceive constant attacks to renewables' deployment "even when issues were not so determinant for them, but meant a great deal for the development of renewables", said one of the heads of the ACERA group.

Shwom (2011) suggests that the relative unity or disunity of business interests is one important factor that shapes the outcomes of sustainability transitions. In line with that, the creation of the Association of Chilean Generation Companies in 2011 speaks about the need for unity and the interest for joining forces that the sector had at the time. Before that, incumbent companies had not formed an industry association and then, their ability to sustain a consensual discourse had been limited. Realizing the need for having a unified voice that gave seriousness and strength to their position they created the association, which until today still represents their group and lobbies for their interests.

The CEO of a NCRE company, which is also one of the directors of the ACERA association commented with respect to the opposition they received:

"when all this started to catch on, they started to get worried […] they formed the Association of Generators that exists thanks to ACERA… when ACERA started to get noisy and to change things, big generation companies were unable to do anything individually, so they had to associate under the Association of Generators of Chile… they realized they had no option if they continued to be dispersed […] and after that they started a brutal contra-lobby… even I received many personal threats at the time. Very serious ones… This has changed over time, getting less intense, mainly because most of the big companies that were attacking us now have de-carbonization plans…", ***CEO, NCRE private sector****.*

"it was difficult, because the think tanks were saying that this was a disaster, and the big electricity companies heavily lobbying… but it was too late, I think if they had started [to do an organized lobby] 5 years earlier they would have been able to stop us more effectively , but they noticed too late… […] and then they themselves realized that this [NCREs] was coming and they had to start introducing the technologies…", ***CEO, NCRE private sector****.*

Perhaps it is important to note that in Chile, though the government maintains an economic-efficiency and neoliberal ideology, at least the more left-wing coalition that is currently in office (the same one that worked for passing the first quota law) did not join a coalition with incumbents for maintaining the regime. When the discussion of the second quota law was held in the parliament though (under a right-wing government), one of the recognized leaders of the incumbent coalition was a government official. He did not held a position in the energy governance sector though, but rather worked for the Ministry for the Economy, Development, and Tourism. Ironically, interviewees described, after he left office he moved to work in the renewables' sector.

If we analyze the resistance to change using Geels (2014) and Avelino and Rotmans' (2009) categories (see section 3.2.5), the Chilean transition exhibit patterns of instrumental and discursive strategies mainly. On the instrumental side, incumbents used their access to media (as the controlling groups of generation companies are the same or closely related to those that control most media), as well as their capacity to pay for studies that discredited non-conventional renewables. Discursive strategies were used by the incumbent coalitions especially when the debates around the two laws occurred, and they decided to sustain their strategy not arguing that the law was prejudicing them, but arguing first that the change was going to be expensive for the country, that renewables were not enough developed and reliable, and then bringing up the intermittence of NCREs and arguing for the technical unfeasibility of the electricity system to receive them. There was much less material resistance, though it is true that conventional generators have improved their generation designs, especially of coal and dam generators to make them look more eco-friendly. On the institutional side there has been much less resistance, as the government has changed institutional contexts in favor of renewables, though undeniably existent models of marginal cost and current regulations give incumbents the advantage.

Today, opposition is perceived to still exist, but to be much less, as incumbent companies have started to slowly join the transition. Incumbents have begun to realize the business opportunity that renewables represent and the momentum that the transition is gaining, and they now also realize the international contingency around climate change, so they have started to change their strategy. This might be a positive signal, but it also represents the risk that many researchers point out of the transition being captured by the incumbent regime (in the sense that incumbent companies might stifle renewables' penetration).

3.4.3. The relevance of social movements for boosting the transition

The renewables' advocacy coalition was clearly strengthen by social movement arousal. Two interviewees commented in this respect:

"[Massive environmental protests…] "…have given visibility to the energy policy debate…" ***Director of environmental NGO 3.***

"I think without the massive protests of Hidroayen and Castilla, the political weight of environmental groups would have been small […] because social movements were the ones that boosted them, that put them in an equality spot [with other political forces]… though they were the ones that articulated all the HidroAysén movement, and in that sense is their merit… these are important instances that I think will have an increasing incidence in the future…", ***Expert, University Professor***.

The active push for the deployment of NCRE technologies maintained by environmental NGOs, activists and industry associations coupled with the strong opposition that communities in general maintained against conventional energy projects from 2005 onwards, which increasingly prevented them to materialize, leaving an unsatisfied demand space that NCRE projects were finally able to claim.

The work of Hess (2007) tells a lot about the incidence of social movements in the achievement of socio-technical change. Indeed, as he identifies two types of movements: industrial opposition movements and technology and product-oriented movements. The Chilean social movements represent a case of industrial opposition that rejected the use of conventional energy technologies, especially coal thermo-electricity generation and large scale hydropower electricity. Though environmental groups joined and helped communities in their rejection for environmental pollution and conventional energy technologies, they recognized that people who supported the movements joined them for a multiplicity of reasons besides environmental motives. Indeed, there is no evidence that communities mobilized for massively supporting the development of NCRE sources. Interestingly, the story of the Chilean environmental NGOs and their relationship with communities is in line with Hess's (2007) argument "A threat to a geographically restricted community represents a tremendous opportunity for mobilization. Leaders of small opposition groups can draw on existing local networks and organizations to form broad, local coalitions that in turn can find support from national organizations looking for on-the-ground connections with present and potential members".

In addition to the above, as Hess (2007) points out, "the moratorium of rejection around which people mobilize can be delegitimized if it is not connected with an articulation of an alternative, just as the motivation for embracing the alternative is powered partly by the perceived flaws in existing industrial practices". So in line with this again, the option of renewables was advanced by environmental groups as the alternative and most convenient solution for energy problems. Three interviewees commented in this respect:

*"Nowadays, for a variety of reasons, and with the communities being one of the most incidential ones, conventional energy projects are all stopped and with lots of problems… […] that has opened a space for renewables' development, which have emerged as an alternative option, and the sector has been able to take advantage of that opportunity…", **NCRE private sector executive**.*

*"…I think that after the Barrancones episode and the Hydroaysen opposition, as well as the opposition to other large thermoelectric power plants, NCREs (including small hydropower) got greater social acceptance than conventional energy technologies…", **Government official**.*

"The social movements, that have been organized mostly by people from environmental NGOs, have had an important voice in generating a discourse in favor of the use of renewable energy…", ***Expert, University Professor.***

With all, the effect that the participation of industry opposition movements had in advancing the Chilean transition and the deployment of renewable energy technologies in the country is difficult to measure. Interviewees seem to coincide with the vision that they exerted influence over parliament decisions, and also affected the expectations that the government and the private and financial sector had with respect to the future development of the renewables' sector. Interviewees generally think that the big support that finally both renewable energy quota laws enjoyed in parliament was in great part due to the opposition movement, as parliamentarians tend to feel accountable for their decisions due to their close relationship with the constituencies they represent. In addition, the strong social opposition and mobilization that conventional energies unleashed finally affected the decisions made by the government and the supreme court with regard to the suspension of the most controversial project, due to both environmental reasons and high political costs. The general opposition to conventional energy technologies also affected the perceptions of the private and financial sectors, with the financial sector more willing to invest in NCRE technologies due to their better acceptance among people in general.

3.4.4. Reflexive governance as a way for legitimizing transitions

An additional outcome that the social vein of the transition caused was what one of the interviewees (a social science researcher) called a "social twist" in Chilean energy policy, which is something that can also be observed in the way businesses are developed in the energy sector, especially clean energy projects.

As was described before, the wide social opposition from local communities to conventional energy projects pushed the private electricity sector to request help from the government for moving forward with their projects. In 2014 the Ministry of Energy created a special unit that started navigating participation and legitimacy aspects of the transition, and later on, the new long-term *Energy Policy* was designed with an explicit effort to make it socially valid. Despite all the flaws of the process with respect to its lack of legitimacy and true participatory and deliberative characteristics, from any point of view it clearly represents a step forward for Chilean energy policy and (arguably) for the Chilean democracy in general.

The private sector was also touched by this "social twist". Many private sector executives from the NCRE sector claimed that the good reception that renewable energy projects have had among Chilean civil society in general has been due to the fact that NCRE companies have changed the unilateral old way of doing business towards one that works closer with communities and tries to generate win-win situations. Indeed, NCRE representatives remark that they have been making explicit efforts for doing early negotiations with communities so that they feel integrated and part of the big decisions that project development entails. At the same time, they try to integrate local communities to projects' activities creating synergies along the way. Even when talking with representatives from the conventional generation sector, they manifest this general twist that energy sector is undergoing, pointing out the importance of good relationships with communities and the importance of generating partnerships for the good development of projects. Without any doubt this "social twist" has represented a step forward for Chilean communities in general, as it is opening a door for an increase in participation with respect to land-use issues and has also open the possibility for communities to get some benefits from the installation of energy projects in their territory.

This "social twist" that energy policy and business development are starting to experience paves the way towards achieving a more democratic energy sector in Chile. It seems that the "natural" avenue that energy policy-makers and the private sector are following for dealing with their opponents is shifting gear towards a more inclusive way of developing projects and arguably a more participatory way of making decisions. This is in line with Hendricks' (2009) recommendations on the potential of deliberation alternatives for legitimizing sustainability policies that arguably can be extended to businesses' development as well. For Hendricks (2009) the legitimacy of such policies rests on the inclusivity and accountability of decision procedures. This idea is also in line with Dryzek's (2001) argument who defends that when deliberative procedures are inclusive of all those potentially affected by a decision, they can generate legitimacy. Moreover, Fischer adds that deliberation can potentially generate more publicly oriented outcomes since policy discussions (and business decisions) expand beyond scientific/professional expertise to include forms of local and tacit knowledge (Fischer, 2009).

Arguably, the Chilean case is in line with Gollagher and Hartz-Karp's (2013) perception of the increasing emergence across the globe of notable examples of decision-making authority being shared among diverse stakeholders that have led to more sustainable outcomes. This gives even more hope to the many optimistic authors that perceive the transition towards sustainable development as an opportunity for innovation in governance in general, not only on the one that concerns environmental sustainability. The management of sustainability would then constitute a first step towards a more democratic face of modern democracy, opening up a decision space that will encourage societal participation and learning.

But deliberation models have also limitations, which have to do with the critiques that researchers in Chile have made of the "social twist" that is affecting both energy policy-making as well as the change in the approach for doing business in the sector. These critiques point out the power asymmetries of such processes and the lack of agency of participants of “deliberative processes”. Certain researchers even warned that such quasi-participatory process might be even more dangerous for democracy than non-deliberative ones, as the chance of re-making policy decisions that are presented as democratic and as the product of a deliberation process is certainly lower than modifying regular non-deliberative decisions.

One of the interviewees, a Chilean researcher (university professor) working on projects related to energy social issues argues that:

> *“On the one hand it is very laudable that they [the government energy sector] have finally realized that this is relevant [the participation vein of social problems], but their approach is very counter-reactive… this is something that is not the result of a government initiative, but rather something that in a certain way the government was forced into, and then this participatory policy, or policy with a “social twist” was born as a counter-reaction to a social movement that had in a certain way kidnapped the energy agenda for several years, almost paralyzed it one could say. So in a certain way this social turn is born against the tide in a ministry that is very technocratic, [...] there is a very conventional approach to social issues”*, ***Expert, University Professor***.

He thinks there is still a fundamental need for passing from *“the public understanding of science to the public engagement with science”*.

Beyond evident problems on the implementation of deliberative decision-making models, I think critiques of the Chilean case relate to the warning raised by some authors with respect to certain flaws of deliberative processes (Mouffe, 2000; Machin, 2013): they critique green deliberative democracy models arguing that they fail to recognize the inevitability of power (that always entails some form of exclusion) and conflict. The professor from the previous quote further argues: *“the problem of these social twists is that instead of contributing to changing the reality, they might contribute to generate status quo”*. Researchers then remark the necessity of explicitly recognizing power inequalities and conflicting interests for dealing with them in a democratic way. This is why Kenis et al. (2016) argue for a more politicized approach to sustainability transitions governance. The participation/deliberation debate in transitions (and in policy in general) is still ongoing and far from over. With all, Kenis et al. (2016) note that will need to start by identifying and recognizing potential fault lines, power relations and forms of exclusion of transition management processes, so as to recognize and raise awareness on the political nature of its endeavor.

3.5. Situating the Chilean case in the context electricity transitions' studies

This section seeks to situate the Chilean ongoing transition in the context of existent transition studies. For that I compare selected aspects from the Chilean case with other case studies that are available in the transitions literature. While it is imperative to acknowledge the context-dependency of transition processes and especially of its political dynamics, contrasting overall characteristics of the Chilean case with national-level electricity/energy transitions from other countries allows to draw some insights from the Chilean experience that might contribute to the analysis of the politics of transition processes. Thus, far from attempting to generalize conclusions from the single Chilean study, this section seeks to identify interesting similarities and differences that might enlighten the understanding of the ways in which political dynamics unravel in different political contexts, as well as to provide a relative perception of the case for researchers that look at it coming from a multiplicity of countries and backgrounds.

In contrast to planned transitions to sustainability that had taken place in Europe, the Chilean transition did not start motivated by a well-defined and clear sustainability goal, though the orientation of policies evolved towards having a consolidated core sustainability component. In that sense, the Chilean transition is far from being a case such as the transition management attempt that the Dutch administration followed when implementing their long-term energy reform towards environmental sustainability in the Netherlands (see Kemp and Loorbach, 2003). The transition management framework assigns to a country's government a predominant role as the leader of the transition process, to be guided based on governmental policies. The Chilean case is different in that sense, as the Chilean government did not emerge as the big leader of an explicit transition process towards a more sustainable future, though the government indeed played a crucial enabling role as it will be explored in the next chapter. It seems that instead, in the Chilean case it were policy entrepreneurs —

industry associations and environmental NGOs in particular, as leaders of the green advocacy coalition,— who constantly pushed for an explicit shift in a more sustainable direction.

Studies of the German energy transition point out the important role that strong green advocacy coalitions have played in transition politics (Jacobsson and Lauber, 2006; Geels et al., 2016; Kumzeko et al., 2016). From long ago, Germany has counted on a strong long-standing green coalition that advocated for investments in energy-related research and development, and later on for the implementation and conservation of radical sustainability initiatives such as feed-in tariff policies. Indeed, German supporters of renewable energy were multitude and constituted an advocacy coalition movement since the late 80s, while in Chile still there is no such consolidated strong group, and the push for the implementation of NCRE policies has required important organization and mobilization. The Chilean case highlights the role that policy entrepreneurs need to play for introducing ideas and pushing for policy change, and in particular the necessary ability that they need to have for being able to constitute a strong support coalition. I think the "European bias" of transition studies has somehow hidden so far the especially relevant role of policy entrepreneurs due to the existence of long-lasting sustainability ideas and coalitions.

Following on the discussion with respect to the role of policy entrepreneurs in transitions, the Chilean case is in line with Laird and Stefes' (2009) claim on the important role that entrepreneurs had in the German transition, as well as with Steinberg's (2001) findings on the crucial role that entrepreneurs had on the implementation of biodiversity policies in Costa Rica and Bolivia. Moreover, the Chilean experience seems also to reinforce Steinberg's (2001) findings on the pervasive influence that international ideas and resources exercise on policy initiatives. In the Chilean case, entrepreneurs also acquired knowledge and adopted policy ideas from abroad (though in a less direct way than in the cases of Costa Rica and Bolivia, as knowledge is nowadays more widespread and accessible), and received support from international NGOs. This highlights the role that the developed world might play in triggering and supporting the transition that is needed in the global South.

The Chilean case seems also different from the way in which transitions have begun to take place in places like Sweden, where transition processes have started with incumbent energy companies becoming part of the process of change (Kronsell et al., 2012). Kronsell et al. (2012) argue that in Sweden, climate policy is dominated by a neo-corporatist tradition with an emphasis on co-operation between the state and established economic actors, noting "there seems to be a strong held faith among Swedish policy makers that […] incumbents of the dominant regime will be able to act as innovators and contribute to regime change". This is the case in much of Europe and in Asia also. The idea is that through a cooperative relationship, businesses can be pushed toward more environmentally friendly policies. On the one hand, it reduces associated legal costs, on the other hand, it is unclear whether it produces better impacts on the environment (and it is certainly not participatory). The electricity transition in Chile was not started in an alliance the incumbent companies, but rather it was firstly pushed forward by new NCRE companies entering the market along with policy entrepreneurs from environmental NGOs (that were in a certain sense part of the energy policy regime from before). With time, incumbents have changed their attitude towards the sector and have slowly started to incorporate renewables to their generation portfolios, which is a tendency that all expectations foretell will continue in incoming years. This has also been the case in the UK (see Geels et al. 2016), Denmark and Portugal (see Kumzeko et al., 2016), where incumbent energy companies had become part of the process of change. This carries the risk for the transition of being encroached by the incumbent regime who generally incorporate only enough demands to steam out mobilization around an issue but in the end do not continue towards adopting more challenging goals, as the literature warns (Hess, 2007; Kronsell et al., 2012; Geels, 2014).

The study of the political dynamics of the transition process that has taken place in the UK electricity system developed by Geels (2014) note as an important characteristic of UK transition policies the fact that resistance of existing fossil fuel regimes is clearly hindering the progress of low-carbon transitions. Furthermore, Geels argues that policymakers and incumbent business actors tend to form core alliances for resisting fundamental change. The Chilean case shows a similar pattern with respect to the formation of incumbent coalitions for resisting change, but it does not exhibit strong alliances between the private incumbent sector and the government. While it is true also in the Chilean transition that left-wing governments have been less prone to ally with the private sector than what was perceived when a right-wing government assumed office, at the core the difference with the UK case might have to do with the idea that the Chile has few indigenous fossil fuel resources. Indeed, some scholars have suggested that oil importer countries, such as Germany, Sweden and Denmark, have longer histories of making their energy systems sustainable by making their economies more energy efficient but also by starting to encourage renewable energy generation (Kumzeko et al., 2016; Giddens, 2009; Di Lucia and Ericsson, 2014). In any case, the resistance of the incumbent coalition seems to exhibit similar forms of power than those described by Geels (2014) and explored in the previous section.

When analyzing the politics of US cases, Hess (2013) and Hess (2014) note the relevance of countervailing industrial power in US transitions. The cases analyzed by Hess (2014) using data of financial spending for supporting ballot propositions of green energy coalitions in several states suggests the relevant role of incumbent regime coalitions, of grassroots coalitions in support of green transition policies, and of countervailing industrial power in US transition politics. Moreover, the analyzed cases show how countervailing industrial power, especially from the technology and financial sector, can tip the balance of electoral spending in favor of grassroots organizations. In contrast, such countervailing power does not seem to be a key one in the Chilean transition, as it does not seem to be the case in many European transitions either (Hess, 2013). The reference to such kind of power in the Chilean transition was only expressed by interviewees when referring to the international support that big environmental campaigns received (e.g. *Patagonia Sin Represas*). Though they do recognize the importance of that support in terms of financial resources and professional capacity in particular, it does not seem to have been a particularly determinant factor in the transition.

Last but not least, another special characteristic of the Chilean case is the way in which the transition has evolved towards contemplating more participation in both the public and private sectors. This new direction seems to be a product of the overall social character of the transition. But though the social twist that has taken place represents a first step and is positively valued in the country, several authors have raised warnings with respect to participation processes that are taking place in other countries. The study of Swedish climate policies developed by Kronsell et al. (2012) critiques the way in which related participation and deliberation processes are governed in Sweden, arguing that "…participation is selective and that it does not emanate from civil society but is rather top-down controlled. Participation is guided by an instrumental rationality to inform, to improve decisions, to increase acceptance rather than a deliberative rationality" (Kronsell et al., 2012). At the same time, in her analysis of recent Dutch energy reforms that have attempted to implement more inclusive governance processes through transition management, Hendriks (2011) finds out that partnerships are dominated by industry and government elites, at the expense of broader democratic engagement. She critiques the Dutch transition management approach arguing that network arrangements have predominantly involved those with expertise, status or connections, while many of those potentially affected by decisions —such as small-to-medium enterprises, diverse societal groups and the broader public— have not been included. In the same page as Swedish critiques, she thinks that this may be a product of the Dutch context where elite neo-corporatist ideas persist in political practice (see Denters et al. 2003). These concerns are in line with those raised by Chilean researchers that fear that processes that are currently taking place will prevent the occurrence of future much more participative instances. Indeed, Hendriks (2011) argues that when "alternative" modes of governing simply replicate the prevailing policy style being unable to break open existing modes and discourses of exclusion (for example, technocracy or elitism), "some groups and citizens may also choose not to participate for fear of co-option or lack of resources", which is precisely what have started happening in Chilean cases when for example national environmental NGOs refused to be part of the *Energy 2050* design process.

3.6. Conclusions: lessons from a developing country case study

This chapter has explored the politics of the transition process that has taken place in the electricity sector in Chile. The study has identified the multiple actors and stakeholders that has been involved in the transition policy process, characterizing the participation and impact that they have respectively had. The Chilean case study sheds light on multiple fronts for the study of transitions' politics, as well as for the design of governance mechanisms for dealing with and steering transition policy processes.

A first observation is that the case reinforces the idea of the crucial role that advocacy coalitions play for the implementation of controversial policy changes, which is most generally the case of policies that involve sustainability-aligned objectives. Although, the Chilean case highlights the role that policy entrepreneurs played in the energy transition process by introducing ideas and pushing and lobbying for them, and especially as builders of advocacy coalitions for enabling policy change, in line with the findings of available studies that analyze policy entrepreneurship in water transitions.

The Chilean case hints that policy entrepreneurs' role might be particularly relevant for implementing transitions in developing countries, where sustainability ideas and green coalitions are not consolidated and need to be developed from early stages. This suggests the need for expanding available research on the role of entrepreneurs and the strategies they use for bringing about policy change by exploring in more depth the role that they might play in other developing countries' cases, and the conditions that allow them to successfully push sustainability policies forward. Additionally, the Chilean case suggests that the international community might be able to exert certain influence in other countries' transitions, not only by setting an example and a world-wide agenda, but also by offering direct support to local organizations that may act as policy entrepreneurs, as it was the case in the Chilean most emblematic cases of environmental conflict.

The Chilean case also reaffirms the theoretical necessity of paying particular attention to the politics of transition processes —including power relationships and different forms of regime resistance— and how they shape transitions' outcome, offering an example of a case where regime resistance is being overcome, leading to the destabilization and decline of the old fossil-fuel dependent regime. The role of policy entrepreneurs and advocacy coalitions was certainly determinant, but also the boost that big social movements gave to the Chilean transition exerting tipping balance pressure for changing the existent energy policy regime. Additionally, the fact that Chilean incumbent companies did not exhibit a high degree of coordination when renewable energy policies started to be discussed and only organized several years later seems to have contributed to opening a space for renewables.

After witnessing the successful profit outcomes of the renewables' sector, as well as their wide degree of acceptance among local communities, incumbent firms have started to increasingly invest in the renewables' sector —particularly those that were acquired by international companies—, and thus to consolidate the transition. The risk that floats up now is that incumbents may appropriate the transition, making it more diluted over time, as the issue gets replaced in the political agenda by other more urgent concerns and the advocacy coalition loses force and adepts. The hope to stick in the transition's path is the integration of renewables as a core pillar of the new energy policy that the Chilean government launched in 2015. The next chapter analyzes in more depth the role played by the Chilean government and the policy programs implemented during the Chilean transition process.

As a side-product of the Chilean transition and its social character are the steps towards participation and legitimation that the government and the business sectors have started to take. The high degree of involvement that policy entrepreneurs, activists and the civil society in general have had in the political process of change, have forced the public and private sector to seek for participation measures as the option for obtaining acceptance and legitimacy. Though this represents a pioneering and hopeful step towards democratic policy-making in Chile, several authors and observers point out the flaws that such processes may carry. It is imperative then to address participatory instances carefully, not risking the discredit of such initiatives before the multiplicity of actors and stakeholders, as they may represent an invaluable opportunity towards the design of more equitable policies and a more sustainable society, with justice and legitimacy at its core. In that sense, the Chilean case further highlights the necessity of advancing deliberation studies and methodologies for policy-making practitioners, but also adds the need for developing them oriented to the private sector. Indeed, the experience of the NCRE sector in Chile seems to indicate a valuable opportunity for advancing transitions from a bottom-up perspective, with companies integrating local communities to projects' development that seek more environmentally-friendly and democratic goals, —which seem to enjoy more social acceptance and cooperation from local communities,— while creating synergies and opportunities with them along the way.

CHAPTER 4. ANALYZING ENERGY POLICY IN THE CHILEAN TRANSITION TO RENEWABLES: THE ROLE OF GOVERNMENT IN ENABLING SOCIO-TECHNICAL CHANGE

4.1. Introduction

This chapter analyses the role that the Chilean government has had in enabling and fostering the electricity transition in Chile, with the aim of identifying in which ways the government has facilitated and allowed the shift towards renewables to start occurring. I expect that the Chilean experience is useful for shedding some light on the role that governments, especially from the developing world, might play for steering and managing transitions. I pay special attention in exploring how implemented regulations have modified the structure of the electricity market and in which ways this has affected the transition.

According to transition theories and experience from other countries, governments are to play a central role in unleashing the needed transitions towards more sustainable practices across different sectors. Transition theories though, do not enter into details with respect to what are the specific functions that governments are expected to perform, leaving room for implementing different approaches. The Chilean government did not follow any preconceived transition management approach. Indeed, the idea of giving renewables an opportunity in the Chilean electricity market was mainly fostered by the government at first for energy security and economic efficiency reasons, though along the years the country has begun to integrate sustainability as a central pillar of its energy strategy. In this chapter I analyze the role that the government has played in Chile's transition arguing that it has been decisive for enabling the transition to start happening. I expect the Chilean experience contributes to learn how governments might approach and address the different elements that are needed for a transition to happen, which is likely to be a process that involves major politico-economic changes.

In this chapter I firstly take a look at several pieces of literature that have to do with the role that governments play in the development and implementation of energy policies: a review of the story of regulation and deregulation in electricity systems and the emergence of the renewable energy paradigm; a quick overview of the rationales for government intervention in the energy sector; a review of sustainability transitions theories and their views on the needed elements for the formation and development of a market niche for triggering transitions; and a brief analysis of literature on the importance of institutional capacity for the implementation of environmental policy. The following section identifies all the activities that the Chilean government played during the last decade including policies, legislations and the creation of institutions, and present overall statistics that intend to illustrate the general results of some of these actions. Then, I analyze the specific actions undertaken by the Chilean government from a sustainability transitions' perspective, identifying what of the elements needed for a transition to take place was present in the transition and specifically which of them where addressed by the government. The chapter ends with a general discussion on the Chilean transition and a set of conclusions that identify the most relevant insights from the Chilean experience.

4.2. Literature review and discussion

In this section I briefly review the role that governments have had with respect to electric power systems over time, exploring how the idea of government regulation in the sector emerged, was followed by the liberalization movement, and then have (arguably) tend to re-regulation in light of the need for a paradigm change towards more sustainable energy practices. After that, I provide a brief review on the rationales for government intervention in the energy sector. Then I explore the general vision of the sustainability transitions research field. Researchers in this field have proposed a series of management strategies for steering socio-technical change, which I briefly present along with the needed elements for the formation and development of market niches for triggering the development of new more sustainable technologies. Then I review the complementary role that institutions (understood as organizations) have in implementing policy strategies, emphasizing experiences with renewable energy policies.

4.2.1. Governments and electricity markets: from regulation to liberalization to re-regulation

The role that the government has had through history with respect to electric power systems has evolved over time. Chapter 1 reviews how the electricity markets have emerged and evolved, requiring the implementation of regulation and deregulation measures that allow for the steering of the electricity sector towards desirable outcomes.

When the electricity business emerged in the late IXX century, it was conceived as a natural monopoly due to physical reasons (economies of scale for generation plants, losses with long-distance transmission, impossibility to duplicate transmission and distribution networks, etc.), and electricity sectors almost everywhere in the world evolved with (primarily) vertically integrated monopolies. These monopolies were either state-owned, or privately-owned and subject to price and entry regulation by the state. Common practice was to integrate the primary components of electricity supply —generation, transmission, distribution, and retail supply— within individual electric utilities. Utility companies had then exclusivity to supply electricity to residential, commercial and industrial retail consumers within a defined geographic area.

Deregulation ideas appeared in the 70s, as technological development in the sector enabled the possibility of implementing competition. With the appearance of deregulation ideas, electricity started to be seen as a commodity, just as any other major standardized good, while during the regulation era, electricity was managed by countries or regions as a public good. In 1982, Chile started running the first modern spot market (Gan et al. 2014), within the dictatorship period that completely privatized and liberalized the Chilean electricity sector. After that in 1990 the UK privatized the Electricity Supply Industry in England and Wales establishing a pool-based electricity market that served many nations for many years as a market model. That process was followed by similar measures and led to a fully deregulated market in 1998, making the UK a pioneer in electricity deregulation. This example was soon imitated throughout the world and triggered efforts whose main common traits were: privatization of state-owned firms, vertical de-integration of utilities, allowance of new entry in the generation market and fully deregulate its prices, and the presence of an independent system operator responsible for reliable grid operation. Thereafter, the EU favored the liberalization of electricity and gas markets passing liberalization packages that aimed at achieving full opening of the electricity markets in 2007 for all EU countries.

The US has never enacted a mandatory comprehensive federal restructuring and competition law, leaving the most significant reform decisions to the states. Many US states have introduced liberalization reforms in wholesale markets. Among them stands out the Pennsylvania-New-Jersey-Maryland market that was created in 1998 and has also served as a worldwide market model, widely acknowledged to function properly reliably providing cheap electricity to consumers (Beneyto, 2010). Yet the case of the energy crisis in California in 2000 and 2001, a state that launched its deregulated electricity market in 1998, braked the deregulation momentum. The state of California, after experiencing its energy crisis due to widespread manipulation and misconduct on part of private providers, decided to back away from deregulation. The California case has highlighted how difficult it is even for a developed country to get the appropriate package of reforms right. This has raised an air of caution among policymakers and proposals are now met with much greater skepticism, though many authors argue that the arguments in favor of a more competitive electric power industry remain attractive (Fox-Penner, 2014). Today, 16 states plus the District of Columbia operate under deregulation reforms, yet seven other states, including California, began the process of electricity deregulation in some capacity but have since suspended deregulation efforts.

In 1983 Joscow and Schmalensee evaluated current popular options for deregulating the electricity sector and advised a balanced program for reform, advocating against total deregulation and recommending a cautious approach to even partial deregulation. So far, different countries have then pursued the liberalization and deregulation of their electricity markets in different ways, often creating/maintaining a regulator entity in charge of overseeing part of the electricity chain. Policy of deregulation packages commonly includes the creation of wholesale markets for power in order to provide incentives for lowering electricity costs, to encourage innovation in power supply technologies, to provide incentives for service quality, and to shift the risks of technology choice, construction cost and operating problems to suppliers and away from consumers (Joscow, 2008). Implementing retail competition for allowing consumers to choose a retail power supplier is another big policy program of electricity deregulation reform. Transmission and distribution sectors, whether privatized or not, have largely remained regulated as legal monopolies, though reforms to traditional regulatory arrangements have generally been perceived as a key complement to the introduction of wholesale markets and retail competition (Joscow, 2008).

Pollitt (2012) has analyzed available evidence from the energy liberalization era, finding that in general market liberalization reforms are associated with improved efficiency, greater investment and access to services, but higher prices for at least some customer groups. According to Pollit (2012), energy liberalization has led to positive and globally widespread but modest efficiency gains across all energy sectors but a lack of clearly visible direct benefits to households in many countries. However, it has significantly improved the governance of monopoly utilities (via independent regulators), the prospects for competition and innovation, and the quality of policy instruments for environmental emissions control (through the emergence of trading mechanisms).

The introduction of competition propitiated the emergence of multiple generators located in different parts of the electricity grid and, along with this new distributed model, technological advances in the last decades enabled the development and incorporation to the grid of renewable energy technologies. In recent decades, these technologies have raised to the top priorities in the international agenda, give the new sustainability paradigms and the threat of climate change, as well as the need for guaranteeing energy security. Though renewables have faced several constraints for entering the electricity market related to cost and pricing barriers, legal and regulatory barriers and market performance barriers (Beck and Martinot, 2004). This in part due to the fact that the structure of existent markets and the associated legislations and institutions were developed when different technological paradigms and priorities dominated and have evolved according to technological and political constraints. Different policy options have been proposed and political forces in different countries have been able to push to some extent the implementations of policy reforms in order to overcome the market entrance barriers that renewables face. These rules and regulations aim again at changing the electricity sector scenario by reallocating risk and creating incentives in favor of clean energy technologies, though results have been limited and much more effective and efficient efforts are needed. In Chapter 1 I provided a review of those different barriers and proposed policy instruments.

The recent report published by the International Energy Agency (IEA) *Re-Powering markets: Market design and regulation during the transition to low-carbon power systems* highlights that "Competitive electricity markets are being challenged by the need to decarbonize electricity production" and thus reaching new environmental goals calls for new power market designs (IEA, 2016). In that sense, there is a need to pay especial attention on how the design of electricity markets enables the transition to a low-carbon electricity system, while maintaining electricity security. The IEA (2016) report indicates that "competitive markets are an important tool, but they must be supplemented by regulation to ensure an effective transition to low-carbon power at least cost".

Among the most studied of renewable energy deployment barriers are those concerned with the cost disadvantage of renewable energy sources which are generally addressed with different policies and financing mechanisms including carbon pricing, feed-in tariffs, cap-and-trade, or renewable energy certificates. A barrier that has received less attention in the literature relates to the need for providing timely and efficient transmission services. In this regard, a World Bank study elaborated by Madrigal and Stoft (2011) notes that "scaling up renewable energy, such as wind and solar, goes hand in hand with the expansion of transmission infrastructure", given the fact that the richest solar and wind renewable energy sites are often located far away from consumption centers or existing transmission networks. According to Madrigal and Stoft (2011), investment needs for transmission expansion to accommodate renewable energy are significant and growing in both developed and developing countries and they require improving planning practices and adjusting transmission cost-recovery practices. Below I look provide a brief overview on how countries and US states have modified their electricity markets for encouraging renewables' deployment.

United Kingdom

Pollitt (2012) notes that in the European Union concerns about emissions of greenhouse gases and energy security have led to pressure for more subsidized renewable electricity and less willingness to depend on the market to decide on investments within the energy sector from 2000. The UK, once a leading proponent of energy market liberalization, have implemented multiple policies and plans for supporting renewables' deployment since the early 2000s. Policy instruments include: Renewables Obligation, an instrument that places an obligation on electricity suppliers to source an increasing proportion of electricity from renewable sources (similar to a renewable portfolio standard) introduced in 2002 and Feed-in tariffs, for supporting small scale renewable electricity installations announced in 2008 and effected from 2010. Particularly in July 2011, the UK government announced an electricity market reform which massively increases government intervention in the market in order to achieve environmental targets (Pollitt, 2012), which The Financial Times labeled as "the biggest upheaval of the electricity industry since privatization 20 years ago" (Financial Times, 2010). Part of those policy measures was the implementation of Renewable Heat Incentives, which was the world's first Feed-In Tariff (FIT) for renewable heat introduced in 2011 (non-domestic) and 2014 (domestic).

In 2010, the UK also started to incentivize the expansion and reinforcement of the transmission system in order to enable the connection of new generation into the national grid, especially new renewable and other low-carbon generation (DECC, 2011). Due to the significant increase in renewable generation from Renewable Obligation (RO) mechanisms, investment needs in transmission and distribution have drastically increased. The higher investment needs specific to the UK are the result of interconnecting wind power generated in the north (Scotland) and bringing it to main consumption centers in the south. In fact, the capital expenditures approved for 2006–12 period tripled because of the higher investment needs needed for transmission network expansion resulting from increasing renewable generation (Madrigal and Stoft, 2011).

Then, as part of the de-carbonization strategy in the UK and in Europe, the regulator entered into a lengthy process to review the existing regulatory models for energy networks (electricity and gas, transmission and distribution). The main driver of this review was to identify a new regulatory model to respond to the new context of the industry driven by the need for lower-carbon development. The review has led to two significant changes: (1) the introduction of a procurement process for the development of offshore networks, (2) and the approval of a new regulatory model for onshore transport energy networks, which places more emphasis on long-term planning by first extending the regulatory review period from the traditional five-year to eight-year period.

But then recently, in 2016/2017, the UK has introduced new policy changes aiming to reduce the expenditure generated by the renewable energy support programs and to create a policy framework that allows for better cost and capacity control, as well as to limit consumers' electricity bills. Such changes include the closure of RO scheme from 2017 onwards, the cut of the amount of Renewable Heat Incentive (RHI) that can be claimed with solar thermal installations being no longer eligible from 2017, and feed-in tariff cuts and deployment caps for different technologies to limit the overall FIT costs. However, these policy changes have created much uncertainty and have reduced the attractiveness of the UK for renewable energy investors (IEA, 2016).

California

In the US, the two states that lead renewable energy generation, California and Texas —two states that also once embraced electricity sector's liberalization—, have implemented multiple regulatory policies for boosting renewables' deployment. In 2002, California established its Renewables Portfolio Standard Program, with the goal of increasing the percentage of renewable energy in the state's electricity mix to 20 percent by 2017. In 2011 the target was increased to 33 percent by 2020, and in 2015 Senate Bill 350 set the ambitious target for retail sellers and publicly owned utilities to procure half of the state's electricity from renewable sources by 2030. The Energy Commission's Renewable Energy Program has so far provided multiple market-based incentives for new and existing utility-scale facilities powered by renewable energy, including rebates for installing new wind and solar renewable energy systems for homes and businesses. The program also helps to educate the public regarding renewable energy.

Recognizing the vital role that transmission expansion plays in enabling the interconnection and deliverability of renewable energy to meet the state's Renewables Portfolio Standard (RPS), the California Energy Commission decided to conduct strategic transmission planning and corridor designation in coordination with the California Independent System Operator (ISO), the California

Public Utilities Commission (CPUC), and federal agencies. In addition, the California ISO conducts its own transmission planning process annually to identify system upgrades needed to meet grid reliability requirements, projects that could bring economic benefits to consumers, and projects needed for the accomplishment of policy targets (California Energy Commission, 2016).

In 2008 state agencies initiated the Renewable Energy Transmission Initiative (RETI), a non-regulatory statewide planning process, established to identify transmission projects needed to support the renewable generation required to meet the 33 percent target (California Energy Commission, 2017). The 2008 RETI was a collaborative, analytical effort that assessed the need for new transmission to connect renewable resource areas to California consumers. In addition to the 2008 RETI, state, federal, and local agencies have collaborated on other landscape planning processes to identify the most appropriate locations for renewable energy development, including the Desert Renewable Energy Conservation Plan and the San Joaquin Valley Solar Project. As a result of that process, California was able to identify transmission needs to meet its RPS. The outcome of the planning process was used in developing the proposed Sunrise Powerlink Transmission project, which was approved in 2010 and rapidly developed coming online on mid 2012, which meant adding more than 1,000 megawatts of renewable energy to the utility's portfolio, increasing its renewable share from 12 percent to 30 percent. In addition, several other transmission projects are in the pipeline for incoming years (California Energy Commission, 2016).

Thanks to these recurrent planning efforts, California has faced only modest curtailment problems, which occur largely due to congestion or periods of oversupply (Bird et al., 2014). Considering that these problems are expected to increase as additional wind and solar generation are added, and given the ambitious targets that the state aims to achieve, the California Natural Resources Agency, Energy Commission, CPUC, California ISO, and US Bureau of Land Management California Office have recently initiated the RETI 2.0 in 2015. RETI 2.0 is defined as an open, transparent, and science-based process that will explore the abundant renewable generation resources in California and throughout the West, consider critical land use and environmental constraints, and identify potential transmission opportunities that could access and integrate renewable energy yielding the most environmental, economic, and community benefits (California Energy Commission, 2017).

Texas

The state of Texas, which fervently embraces a market liberalization ideology have also implemented increasing regulatory measures for pushing renewables' deployment. Thanks to that, Texas has experienced a wind power boom in the last decade, and solar energy deployment is also starting to gain momentum. While the development of renewables is generally encouraged for combating climate change, skeptical conservative Republicans in Texas have backed renewables' deployment motivated by cost reasons and job creation (Flakus, 2016).

Texas firstly adopted an RPS in 1999, requiring 2,000 MW of new renewable energy capacity to be installed statewide by 2009. In 2005, the Texas Legislature extended the RPS to expand the state's generating capacity from renewable energy sources to 5,880 MW by 2015 and included a target of 10,000 MW by 2025, with 500 MW coming from non-wind sources. The state's installed capacity reached the 10,000 MW target in early 2010, 15 years ahead of schedule (Texas Wide Open for Business, 2014).

The success of the state's RPS and wind industry led to increasing constraints in transmission capacity and consequent curtailment problems. Wind resources are greatest in west Texas, while the majority of the population and power demand lies in the eastern half of the state. Furthermore, West Texas wind blows hardest at night when energy demand and prices are low. Indeed, in recent years Texas experienced serious wind energy curtailment rates, but since then the state has added transmission capacity and curtailment levels have fallen (Maggio, 2013). In response to these challenges, the Public Utility Commission of Texas (PUCT) collaborated with ECORT in 2008 to expand the Competitive Renewable Energy Zone (CREZ) initiative —which had been authorized by the Texas Legislature in 2005, identifying five "competitive renewable energy zones" with high wind power potential— authorizing the build-out of a series of transmission expansion projects in advance of anticipated wind development primarily in west Texas, that in total would allow 18,500 MW of wind power to be transported from the five CREZ zones to the rest of the state. The lines were completed in early 2014 at a cost of approximately $6.8 billion (Wolff, 2014), enabling Texas to provide three times as much available wind power as any other state. Although, some of the wind development in west Texas came online in advance of the transmission expansion, resulting in significant wind energy curtailment.

Curtailments of wind generation on the Texas electric grid have steadily dropped since 2011 as more than 3,500 miles of transmission lines have been built, largely as a result of the state's CREZ program (Texas Wide Open for Business, 2014). According to Bird’s et al. (2014) assessment, curtailment problems in Texas have dramatically dropped in 2012 and further in 2013 thanks to transmission expansion, as well as to a market redesign to Locational Marginal Princing (LMP) mechanisms and other adjustments that improved overall system operations.

Over the past several years, the US Federal Energy Regulatory Commission (FERC) has issued a number of rules that have been seen as instrumental for integrating renewable energy, demand response and other clean technologies into the grid. In 2011, the FERC issued Order 1000, a ruling that sets up a complex and mandatory new way for transmission operators and utilities to plan for, and pay for, regional grid investments. Order 1000 requires mandatory coordinated planning for grid investments that affect multiple states and utility jurisdictions, rather than the voluntary system that left most plans in the hands of individual state regulators and utilities. It also demands that these plans take into account state policies on carbon reduction and renewable energy integration.

As it is possible to observe, all the aforementioned cases reflect the pattern of needing introduce special electricity regulations and planning components for fostering the use of renewable energy technologies and steering systems towards desired outcomes. In section 4.5.2 I will revisit the cases for comparative purposes with the Chilean case.

4.2.2. Rationales for public policy

Gallagher et al. (2012) discuss the different rationales that justify the need for implementing government policy that fosters energy innovation. A first rationale for government involvement is to support, complement, and leverage the private sector's efforts as a vibrant energy sector contributes to economic growth and prosperity. In addition to that, there is the fact that many energy services contribute to meeting fundamental human needs, and then advancing those services can improve the human condition. Innovation may also reduce the costs of energy access, and then consumer welfare and human well-being are improved. Moreover, in developing countries where millions of people still lack access to electricity (and with that to lighting and refrigeration), governments have a crucial role to play in designing systems to improve energy access. Government policy and investment in energy innovation are also justified to make energy supply more reliable and secure. Government intervention is also needed to curb externalities, especially to reduce pollution (including greenhouse gases that cause climate change) as well as to reduce the negative impacts of energy production and use on water and land resources.

On top of the above, there is the rationale of overcoming or removing market barriers. Indeed, incumbent energy technologies or systems have institutions, infrastructure, and policies that support them, providing barriers to entry for new technologies (sometimes called lock-in or path-dependence of existing systems, in reference to the idea that they are difficult to dislodge) (Unruh, 2000). Governments can help to reduce these barriers and speed the adoption of new (more favorable) technologies by implementing adequate policies.

4.2.3. Sustainability transitions theories

The emerging research field of sustainability transitions is motivated by the great sustainability challenges of our time. Researchers in the field argue for the need of radical socio-technical change for addressing them, which will need to comprise changes in technology, the economy and social structures. Technological innovation plays a central role as an essential mean through which transitions are to be achieved. Researchers in the field of sustainability transitions have focused in studying transition dynamics and —assuming that socio-technical transitions are manageable to some extent— in developing strategies for steering socio-technical systems into a more sustainable direction.

So far the field do not have a unifying theory neither for explanation nor for management of transitions, and several approaches have been proposed in the literature. One common ground between them is the role that (generally) they assign to governments and governmental institutions (in the sense of organizations). Indeed, sustainability transitions management approaches assign government policy a key role to play in the promotion and diffusion of alternative developmental paths, such as those promoting sustainability (Kern and Howlett, 2009). The government is generally seen to have a guiding role in the transition, being responsible for enabling spaces and circumstances for the transition to take place, as well as for making sure that transition processes follow an appropriate direction towards sustainable change. This implies that many times the government will need to implement regulations and make sure the appropriate institutional frameworks exists for enabling and supporting different transition processes. Importantly, steering transitions to sustainability is not expected to be an easy managerial task, but rather the process is likely to involve 'tough' political struggles about the relative importance of different policy goals, as well as about the design and implementation of suitable instruments to achieve them. Moreover, existing interests, ideas and institutional path dependencies will inevitably shape these struggles (Kern and Howlett, 2009).

Another commonality between sustainability transitions management approaches is the existence of a protected space for market formation where new technologies are expected to develop and gain strength for then escalating and push forward sustainable change. For the creation of such space, strong policy instruments are needed to ensure that the adequate conditions exist (Kern and Howlett, 2009). The protected space for developing innovations is called a niche. Among transition approaches, there are some that put particular emphasis on understanding how such niches emerge and what are their development dynamics, namely technological innovation systems (TIS) and Strategic Niche Management (SNM). Such approaches study niches with the aim of developing management strategies for enabling and pushing niche development, and for ultimately through them fostering and steering transitions to more sustainable practices.

Technological innovation systems

An innovation system has been defined in the literature as a network of actors and institutions that develop, diffuse and use innovations (Markard and Truffer, 2008; Bergek et al., 2008). Within the innovation systems field, the TIS approach is primarily the one that focuses on the development, diffusion and use of a particular technology in terms of knowledge, product or both (Bergek et al., 2008). Broadening the market failure approach as a basis for policy action for considering it insufficient for achieving sustainability, TIS literature suggests the use of a systems approach (Bergek et al., 2008) that broadens the concept of market failures to a more comprehensive set of system failures that are defined as the rationale for government intervention by the field (Markard et al., 2012; Negro et al., 2012). Systems failures include market structure problems, infrastructure problems, institutional failures, interaction problems and capability problems (Negro et al., 2012). Aiming at helping policy-makers to identify system weaknesses, researchers in the field have identified a set of functions or processes that need to take place for an innovation system to develop. Identified functions related to knowledge development, resource mobilization, market formation, influence on the direction of search, legitimation, entrepreneurial experimentation and development of positive externalities. Through the analysis of these functions, the TIS approach proposes a methodology for policy-makers for assessing the performance of the emerging system, analyzing inducement and blocking mechanisms, and identifying key policy issues as well as setting policy goals (Bergek et al., 2008).

From the literature on product/industry life cycles, researchers in the TIS field have identified two main phases in the evolution of a product or industry: a formative phase and a growth phase (Jacobsson and Bergek, 2004). The formative phase is characterized by relatively long development periods (rarely shorter than a decade), substantial (technological and market) uncertainties, underdeveloped price/performance ratios of products, relatively small volumes of production and economic activities (compared to estimated potentials), unarticulated demand and an absence of self-reinforcing features (Bergek et al., 2008). The formative stage is followed by a growth phase that corresponds to a period of market expansion in which “the focus shifts to system expansion and large-scale technology diffusion through the formation of bridging markets and subsequently mass markets" (Bergek et al., 2008).

The formative period is characterized by four features that speak about the process of how a new technology emerges: market formation, the entry of firms and other organizations, institutional change and the formation of advocacy coalitions. Market formation normally involves exploring niche markets, where the new technology is superior in some dimension (Jacobsson and Bergek, 2004). These markets might for example be created by a government subsidy, and/or they might be commercial and involve unusual selection criteria (Levinthal, 1998). Such markets correspond to protected spaces for the new technology and may serve as nursing markets (Ericsson and Maitland, 1989) where learning processes can take place, the price/performance of the technology be improved and new customer preferences formed. These markets provide an incentive for the entry of firms into various parts of the value chain, offer opportunities for the development of user-supplier relations, and generate a space for the new industry to evolve in (Jacobsson and Lauber, 2006).

Institutional change (or institutional alignment) —and by implication its politics— is at the heart of the process whereby new technologies gain ground (Freeman and Louca, 2002). Institutional change includes alterations in science, technology and educational policies, but also comprises changes in the value base, market regulations, tax policies, etc. Indeed, the nature of the institutional framework influences access to resources, availability of markets, as well as the legitimation of a new technology and its associated actors (Jacobsson and Lauber, 2006). Moreover, firms in competing technology systems not only compete in the market for goods and services but also to gain influence over the institutional framework (Van de Ven and Garud, 1989; Davies, 1996).

Advocacy coalitions play also a determinant role during the formative stage of new technologies. According to political science literature, policy making takes place in a context where advocacy coalitions —made up of a range of actors sharing a set of beliefs— compete in influencing policy (Sabatier, 1998; Smith, 2000). According to TIS researchers, for a new technology to gain ground, technology-specific coalitions need to be formed and to engage in wider political debates in order to gain influence over institutions and secure institutional alignment. Furthermore, advocates of a specific technology need to build support among broader advocacy coalitions to advance the perception of a particular technology and to develop joint visions about it with the objective of shaping the institutional set-up.

Last but not least, the entry of new firms may shape new technological systems in three main ways. First, each new entrant brings knowledge and other resources into the industry. Second, new entrants enlarge the technological system by filling "gaps" (e.g. by becoming specialist suppliers) or by meeting novel demands (e.g. by developing new applications). Third, early entrants raise returns for subsequent entrants in a number of ways, i.e. positive external economies emerge. In addition, early entrants strengthen the political power of a technology-specific advocacy coalition and provide an enlarged opportunity to influence the institutional set-up. Early entrants also drive the process of legitimation of a new field, improve access to markets, resources, etc. for subsequent entrants, and resolve underlying technical and market uncertainties (Lieberman and Montgomery, 1988).

When investments have generated a large enough and complete enough system for it to be able to 'change gear' and begin to develop in a self-sustaining way, a "take-off" into a rapid growth phase may occur (Carlsson and Jacobsson, 1997a; Porter, 1998; Jacobsson and Lauber, 2006). In this phase, the focus shifts to system expansion and large-scale technology diffusion through the formation of bridging markets and subsequently mass markets (Bergek et al. 2008). Virtuous cycles are formed as the diffusion process becomes increasingly self-sustained and characterized by autonomous dynamics (Rotmans et al., 2001). All four features of the formative phase are involved in such dynamics. Under what conditions a 'take-off' takes place seems to be extremely difficult to predict. A necessary condition is, however, that larger markets are formed; there must be an underlying wave of technological and market opportunities (Jacobsson and Lauber, 2006). Jacobsson and Lauber (2006) studied the development process of wind power and solar cells in Germany noting that "it has been alterations in the regulatory frameworks that triggered a set of actions and reactions and propelled the diffusion process", with a "battle over institutions" lying at the heart of the transition story.

<u>Strategic Niche Management</u>

The SNM governance approach represents a policy vision on how to induce transitions based on the knowledge and understanding of them gained using the Multi-Level Perspective (MLP). This literature argues that technological regime shifts occur as a process of niche proliferation, with niches being understood as protected spaces for the development of new, more sustainable technologies. The SNM approach suggests that one possible strategy to manage the transition process is to create such temporary protected spaces for learning and development of pilot and demonstration projects, that may provide the space for new socio-technical configurations to grow and potentially scale-up, acting as building blocks for achieving broader societal changes (van den Bergh et al., 2011). Governments are expected to play a central role in niche creation and to act as enablers or facilitators that make sure that objectives are accomplished (Kemp et al., 2007). Nonetheless, governments are not expected to create niches in a top–down fashion, but to do so through a process of endogenous steering or "steering from within" (Schot and Geels, 2008).

Smith and Raven (2012) have further advanced the discussion on the role of niches —which they describe as "protected spaces" for path-breaking innovations—, arguing that they exhibit three functional properties: shielding, nurturing and empowerment. Shielding involves processes that hold at bay certain selection pressures from mainstream selection environments (e.g. industry structures, technologies and infrastructures, knowledge base, markets and dominant user practices, public policies and political power, cultural significance). Nurturing involves processes that support the development of path-breaking innovation. These processes can be *passive* protected spaces, that is, generic spaces that pre-exist deliberate mobilization by advocates of specific innovation, but who exploit the shielding opportunities they provide, or they can be *active* protected spaces, defined as those spaces that are the result of deliberate and strategic creation by advocates of specific path-breaking innovations to shield regime selection pressures. Empowering involves processes that make niche innovations competitive within either unchanged selection environments (fit-and-conform pattern), or processes that change mainstream selection environments favorable to the path-breaking innovation (stretch-and-transform pattern). According to Smith and Raven (2012) "relationships between shielding, nurturing and empowerment can be understood as an iterative process: initial, passive protection enables early nurturing of the innovation, whose promise (if successful) empowers niche advocates to obtain more active protective measures that assist in further nurturing, greater empowering, and eventually the institutionalization of the innovation within a transformed selection environment".

Smith and Raven (2012) have noted that the TIS approach provides a detailed framework for understanding nurturing of innovations, with the actual success of innovations being mainly regarded as a consequence of the performance of the innovation system itself. Markard and Truffer (2008) critique the TIS approach, however, for being inward looking and not paying much attention to the system's environment. Thus, Smith and Raven (2012) argue that the TIS approach underplays the shielding of emerging innovation systems against mainstream selection pressures, and then is only able to study the internal consequences of dynamics in the wider selection environment upon an emerging system. In that sense, the TIS approach does not emphasize the interplay between the wider selection environment of an emerging system and internal system dynamics as an endogenous explanation in the emergence of that system. This implies that the TIS analysis will find it difficult to explain mass-market diffusion of path-breaking innovations, because that would inevitably involve many interactions between an emerging system and its environment.

These approaches provide certain frameworks of conditions that are necessary for a transition to occur, e.g. for a new technology to be developed in niches that are protected from selection pressures, while it gains momentum and strength before it starts to compete with incumbent technologies in the market. Then, by identifying what needs to happen for a transition to take place, the described theoretical frameworks are useful for assessing the role that the Chilean government played in enabling the electricity transition process that occurred in Chile.

4.2.4. The role of institutions in implementing policy change

An additional last point to take into account for this chapter's analysis is the importance of having the appropriate institutional capacity for policy making. Though in the literature *institutions* can be both formal (e.g. procedures, laws and regulations) and informal (e.g. values, norms, traditions, codes and conducts that are tacit), in the following discussion I use the term institutions understood as *organizations*, as I am interesting on examining the importance of governmental institutions in enabling policy change.

The literature on environmental policy has put attention on the role that governments' institutional capacity has played in the implementation of environmental policy reforms. Young (2002) argues that in addition to other factors, institutions figure prominently in most accounts of strategies for preventing large-scale environmental changes. Willems and Baumert (2003) note that national-level institutional capacity —defined as ''the ability to perform functions, solve problems and set and achieve objectives''— varies across countries, and that institutional capacity is crucial for countries seeking to design and implement effective climate change-related policies and measures. Laird and Stefes (2009) empirically found that Germany's greater institutional capacity compared to the United States' was central to its early success in deploying renewable energies, particularly the creation of the German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety. In the same vein, Lipp (2007) notes how institutional capacity in Germany and Denmark developed through the feed-in-tariff scheme, explains their success relative to the UK. In addition, Hughes (2012) shows that Japan's pro-active system of subsidies and regulations is shaped by its comparatively well-developed institutional capacity.

Multilateral organizations put special emphasis on the need for expanding institutional capacity in developing countries for achieving environmental and development transformations. Most World Bank documents indicate that institutional capacity building (on part of governments) encompasses three main activities: (i) skill upgrading, (ii) procedural improvements, and (iii) organizational strengthening (Langaas et at., 2007). Defined this way, building institutional capacity implies acquiring resources (human, financial, networks, knowledge, systems and culture) and integrating them in a way that leads to change in individual behavior and ultimately to more efficient and effective operations of institutions and organizations.

In addition to the above, the literature on sustainability transitions presented in the previous section also assigns (less explicitly) a predominant role to institutions (organizations) for the development and implementation of policy reforms that will be needed for carrying out a transition. Moreover, Berkhout et al. (2010), in the context of analyzing transitions in Asian developing countries, argue that learning and technology diffusion face multiple institutional barriers, with a critical uncertainty around many highly novel innovations being the lack of regulations enabling market entry. They highlight that the capacity of regulators to generate such rules is critical to the innovation and diffusion process.

In sum, the literature related to environmental policy and transitions is aligned on the relevance of institutions for the implementation of policy change. In that sense, paying special attention to the existent and new institutional capacity is another key dimension for analyzing the governmental role in enabling socio-technical change, especially in developing countries' contexts.

4.3. The role of the Chilean government in the energy transition

This section describes relevant political decisions and policies related to the energy/electricity sector that the Chilean government decided on and implemented during the last decade. I have classified governmental actions in three groups; (1) actions that relate to energy policy design, (2) legislations that aim at reorganizing the electricity market, and (3) policies that determine the creation of different types of institutions.

4.3.1. Energy policy

Table 4.1. Chilean energy policies and programs.

Year	Policies and Programs
2005	Start of the Country Energy Efficiency Program (in Spanish *Programa País Eficiencia Energética*).
2008	Publication of the document *Energy Policy: New Guidelines*.
2009	*Chile: Energy Policy Review* elaborated by the International Energy Agency.
2011	Electric Development Advisory Commission (in Spanish *Comisión Asesora para el Desarrollo Eléctrico*, CADE) gets convened by the government.
2012	*National Energy Strategy 2012-2030* is launched during the government of President Piñera.
2014	*Energy Agenda,* a new program for the development of a new energy policy is launched by the new government.
2015	The new Chilean energy policy *Energy 2050*, which establishes a set of long-term goals for 2050, is launched by the government.

During the dictatorship regime in 1982, Chile started a process of privatization and liberalization of its electricity sector. With that, the sector came to be ruled almost only by market principles, with three underlying principles of Chile's energy policy: private initiative, competitive markets and the subsidiary role of the state. This meant that energy policy in Chile was founded on the premise that the best way to meet the demand for energy at prices that consumers could afford was: to rely on competition between privately owned entities wherever possible; to regulate where it is not (i.e. in the natural monopolies); and to limit the role of the state in entrepreneurial activities (IEA, 2009). Thus, aligned with the neoliberal ideology that has prevailed in the country since the 70s, the sector had no national long-term policy strategy until recently, in an attempt for minimizing state intervention in the economy, as it was believed that the market would yield the most convenient outcomes for the Chilean society. In particular, it was also assumed that competitive markets would deliver an appropriate level of security of supply. Indeed, until the middle of the last decade, it was of common understanding in the country that Chile's energy policy "was to have no policy". At the time, the national organization for overseen the sector's operation, the National Energy Commission (in Spanish *Comisión Nacional de Energía*, CNE), tried to keep track of projects' plans and made recommendations about how to proceed, but decisions (and information) were almost entirely in the hands of the private sector.

This absence of policy left Chile with no backup plan during crises, including a major drought of late 90s and the big gas crisis with Argentina. When the latter happened in 2004, the government started to realize the importance of having a national long-term energy policy strategy, especially given the dependence on energy imports that the country suffers from due to its lack of fossil fuel resources. By 2007/2008, when the effects of a new drought coupled with those of the gas crisis, the government finally realized the imperative necessity of having a policy strategy for the country; a vision that represented a plot twist of the traditional approach of the sector.

In 2008, the CNE published a document entitled *Energy Policy: New Guidelines,* which can be considered a first draft of a long-term energy policy for Chile. Importantly, that document incorporated the idea of generating electricity from Chile's vast renewable energy resources, an option that the government had started to seriously consider at the time in preparation for the first NCRE law, which implemented a quota that required big generation companies to provide an increasing percentage of the electricity they generate to come from NCRE sources (the law will be described below). The interest on NCRE technologies emerged according to interviewed government officials at the time, with three objectives in mind: energy security, economic efficiency and environmental sustainability. They point out though, that the most relevant objectives were to diversify the generation matrix for energy security reasons and for increasing competition in the sector, and through that lowering the sky-rocketing energy prices that Chile faced at the time. Environmental sustainability was low in the list of priorities.

In 2009, the IEA published a report called *Chile: Energy Policy Review*, with their outcome from an in-depth evaluation of the Chilean energy sector at the time. In that report, the IEA (2009) praised the results of obtained by Chile from the liberalization of its energy market describing the country's experience as a "successful example of electricity market liberalization", but emphasized the essential role that the state was to play in guiding the evolution of the energy sector, and in ensuring energy security and emergency response. The IEA encouraged Chile to develop a long-term energy policy and to diversify its energy mix, particularly through the vast renewable energy resources of the country, among other recommendations.

Several stakeholders of the energy sector, took committed part in the development of a NCRE vision for the country, taking advantage of different instances for advancing the topic. In 2009, for example, the group *Escenarios 2030* (in English *Scenarios 2030*) started to operate. *Escenarios 2030* was a working group constituted by actors from environmental NGOs, from the public and private sectors, and from universities and the civil society. The group was convened by an alliance of institutions and energy-sector stakeholders, and aimed to open a discussion space of different potential scenarios of energy and electricity generation for 2030, with the aim of generating insights for the elaboration of energy policy. The group continued working until 2014.

Importantly, in 2010, the right-wing coalition gained the presidency, which represented a shift from the left-wing coalition that had held the office for long before. Despite the political twist, the idea of developing an energy policy prevailed. In 2011, after the massive protests against the *HidroAysén* project, —which planned to build several dams in the Patagonia region—, the government in office convened the Electric Development Advisory Commission (in Spanish *Comisión Asesora para el Desarrollo Eléctrico*, CADE) for developing and suggesting future energy policy pathways. In parallel, parliamentarians, environmental NGOs and civil society organizations convened a similar commission, named Commission of Citizens, Technicians and Parliamentarians (in Spanish *Comisión Ciudadana Técnico Parlamentaria*, CCTP) also for discussing future energy policy options. At the time, the second NCRE law —that expanded the NCRE quota previously established— was being discussed in the parliament, and the respective outcome documents enlightened the discussion. Importantly, both reports reaffirmed the strategic importance of further encouraging electricity generation from renewables in the country.

In 2012, the government in office (still from the right-wing coalition) launched the *National Energy Strategy 2012-2030* (Ministry of Energy, 2012), that proposed a series of pathways and restated formal support for renewables' deployment.

Later in 2014, the left-wing coalition regained office and decided to work on a new energy policy strategy. They started working on defining a policy process (called *Energy Agenda*) for elaborating a "socially validated" national energy policy. The need for social validation had emerged from the vigorous opposition that electricity generation projects had faced during previous years. The *Energy Agenda* comprised a participatory process for the development of a new long-term energy policy, as a way to legitimize both the outcome policies but also the process through which decisions were to be made. At the very end of 2015, after 2 years of work, that included expert committees, policy committees —where they tried to convene all stakeholders in the sector—, and open working groups in all of the country's regions that convened the general population, the government published a new energy policy called *Energy 2050* policy (Ministry of Energy, 2015). The document states: "The *Energy 2050* policy proposes a vision of Chile's energy sector by the year 2050 as being reliable, inclusive, competitive and sustainable. This vision is part of a systemic approach in which the main goal is to achieve and maintain the reliability of the entire energy system while meeting sustainability and inclusion criteria and contributing to the competitiveness of the nation's economy. These attributes allowed us to establish the goal of moving towards sustainable energy in all of its dimensions" (Ministry of Energy, 2015).

The policy document proposes the goal of achieving 70% of the Chilean energy mix coming from renewable energy sources by 2050, and 50% by 2035 (this includes both non-conventional sources as well as large hydroelectricity projects). Indeed, the policy declares sustainability as one of the four major pillars of the national energy strategy. The document has been criticized on many fronts, especially for the flaws of the participation process through which the policy was designed, as well as for setting ambitious goals but lacking explicit directions for achieving proposed targets. With all, it corresponds to the first formal long-term energy policy of the country. Table 2.1, presented at the end of Chapter 2 depicts how the energy policy paradigm has changed in Chile, from one that considered electricity as a commodity towards one that sees it much more as a public good.

4.3.2. Legislation

Table 4.2. Chilean legislation.

Year	Legislation
2004	Law Nº 19.940 is passed, also called Short Act I (in Spanish *Ley Corta I*), which improves the safety of the energy supply transportation system and exempts transmission charges for new renewable energy sources below 20 MW of capacity.
2005	Law Nº 20.018 is passed, called Short Act II (in Spanish *Ley Corta II*, which improves the safety of the energy and electricity sector.
2008	Law Nº 20.257 is passed, called NCRE law, which requires utility companies to produce 5% of their electricity from NCRE sources by 2014, with the target rising 0.5% per year to 10% by 2024.
2012	Emissions regulation for thermoelectric power plants is passed.
2013	Law Nº 20.698 is passed, called Law 20/25, which makes changes to the NCRE quotas previously established, increasing the requested energy on generating companies that perform withdrawals. Growths defined in this regulation mandate that by 2025, 20% of the total energy generated must come from a renewable source. This law was an initiative of a group of parliamentarians.
2012	Law Nº 20.571 is passed, called *Net-Metering Law*, which regulates the payments of tariffs for residential generation, establishing discounts and refunds when applicable.
2015	Law Nº 20.805 is passed, which modifies the General Law of Electrical Services regarding supply tenders, replacing the old system of biding for power blocks to one that allows bidding for hourly energy blocks.
2016	Law Nº 20.928 is passed, called *Tariff-Equity Law,* that introduces equity mechanisms for diminishing the differences in electricity bills between urban and rural areas.
2016	Law Nº 20.936 is passed, called *Transmission Law*, which creates a new transmission system and a new independent coordinating institution (new CDEC for the new interconnected SIC-SING system).

Around 2002/2003, back when renewables where not on Chile's energy policy agenda, national environmental NGOs along with some activists proposed the government a legislation draft for implementing a series of policies to foster the development of renewable energy technologies in the country (Chile Sustentable, 2003). At the time, they proposed the implementation of subsidies for that end, but the proposal was not much fruitful. Through their push and lobby, they did obtained a modest commitment for the exemption of transmission charges for renewable energy and small generation plants that was implemented in Law Nº 19.940 in 2004 also called Short Act I (in Spanish *Ley Corta I*), which was passed for improving the safety of the energy supply transmission system. Specifically, that law granted exemption total from transmission charges to all projects below 9MW (including NCREs) and partial exemption for NCRE projects between 9 MW and 20 MW. Importantly, that was the first time when the concept of NCRE technology sources was introduced, thanks to the lobby of civil society organizations. Shortly after that, in 2005, a second transmission law, Law Nº 20.018 called Short Act II was passed, which further improved the safety of the energy and electricity sector.

In 2007, after facing the consequences of the gas crisis with Argentina, which at the time started to couple with a devastating drought that lasted around 7 years, the government started to seriously consider the option of electricity generation from renewables. According to the government's diagnosis, renewable energy sources were being developed in other countries (mainly in Europe) and were showing promising price expectation curves for the incoming years, though the technologies were not penetrating the electricity market promisingly in Chile. Interviewed policy-makers working in the energy sector at the time identified two factors that according to them were preventing the proper deployment of NCRE sources in the country, even though Chile counted with plenty of natural resources: (1) traditional generators were used to their classic technologies, they had the know-how for that and did not have enough incentives for making the effort of investing in these new technologies at a much smaller scale, and (2) new entrants were not willing to take the risk that entering in the complex Chilean electricity market required (the operation of the Chilean electricity market and its associated risks is reported to be difficult to understand for investors and for the financial sector).

At the time renewable energy technologies, solar photovoltaic and wind turbines in particular, were not cost-effective, but prediction curves indicated positive projections. Government officials in office at the time explained to me in the interviews that they valuated available options looking at experiences from other countries (mostly Europeans) and decided to adopt a quota strategy instead of the commonly used subsidies. They argued that the reasons for picking that decision were several:

a. Subsidies were not justified, as it was considered that European countries had already subsidized the development of these technologies. (Many interviewees pointed this out.)
b. Subsidies were (and still are) a very difficult policy to implement in the Chilean context, characterized for a predominant neoliberal regime, which implies very limited use of such instruments and a very reluctant attitude for approving them.
c. Chile, as an emerging economy could not afford to spend money in subsidizing clean energy technologies as there are other priorities.

As mentioned in the previous section, when considering the possibility of encouraging the use of renewables in the country the government had three objectives in mind: energy security, economic efficiency and environmental sustainability. Interviewed policy decision-makers at the time confirm that the most relevant objective was to diversify the generation matrix, which was a matter of energy security because of the import's dependence that Chile had, as well as for increasing competition in the sector with the aim of lowering energy prices. Thus, at the beginning, the Chilean energy transition was not mainly driven by the intention of seeking sustainability.

Government leaders from the energy sector at the time explained that the intention of the quota law was to establish a market for renewables. In that sense a quota law was thought to be enough for accomplishing that objective. At beginning, the government proposed a law with 5% of electricity generation required to come from NCRE sources, but the parliament finally modified it requiring big generation companies with more than 200 MW of installed capacity to guarantee that at least 10% of the electricity generated every year came from NCRE sources (either their own or contracted), with the percentage gradually increasing in 0.5% every year from 2014 onwards until 2024, when 10% of the generation mix must come from NCRE sources. The major incumbent companies that dominated the market and the opposition from the right-wing sector (including think tanks and parliamentarians) heavily opposed the law project, arguing that renewable electricity generation was expensive, and was not affordable for a developing country like Chile, whose CO_2 emissions were less than 2% of the world's. Despite that, and after tough discussions, Law Nº 20.257 was passed in 2008 with the full support of Congress.

Despite the fact that renewable energy quotas do not correspond to explicit subsidies, something that makes Chilean policy-makers and the private sector very proud, renewable energy quotas have subsidy-like qualities because they guarantee a role for a higher-priced generation technology. In the developed world, renewable energy quotas have been often implemented along with Green Credits (or tradable Renewable Energy Certificates), such as the cases of the UK ROs, or the Renewable Portfolio Standards implemented in the US. In contrast to that, the Chilean quota law did not comprise the implementation of a trading scheme of green certificates. According to the former director of the CNE, the government at the time did not want to introduce an additional price system that complicated even more the understanding of the electricity system's operation. This is why they designed a mechanism that was simple and technology neutral. The obligation was enforced by the definition of fines to be paid by generators that failed to meet the required targets, though in practice, the enforcement mechanism never got to operate as targets have been always met.

The former director of the CNE noted that it was challenging to decide on both the NCRE target and the penalties. Indeed, it is precisely on that decision were the economic efficiency of the instrument got determined; penalties needed to be significant enough to make it worth it to start investing on renewables (or to buy from renewable energy generators), while they needed not to impose a significant burden on generators, since in the case that renewable energy technology prices did not drop as expected or energy production was not efficient enough, this would have ended up diminishing economic efficiency and increasing energy prices. Costs were to be borne by big generation companies, though research on renewable energy instruments has noted that such costs end up being passed to consumers (IRENA, 2012). Compared to FITs, which have been regarded as more effective for promoting renewables' deployment and more economically efficient at reducing investors' risk (Held et al., 2010), quota instruments are found to be less expensive, considering that FITs often involve high subsidy rates, especially for less mature renewable energy technologies. In general, quota-trading mechanisms have also been criticized for involving higher regulatory and administrative costs than FITs, though the absence of a trading mechanism in the Chilean case lowered transactional costs and simplified the mechanism at the expense of achieving less economic efficiency and reducing the instruments' effectiveness. In addition, quota mechanisms have the drawback of favoring the deployment of more mature (and less expensive) technologies, as they encourage competition among them.

With respect to the effect of the quota law, one of the interviewees mentioned:

"Quota law sends a signal … it pushes the system forward ***[…]*** *The renewables legislation was a timely promoter of what was coming and without it we would have lost several years in their*

introduction [of renewables] …The State, then, is always going to be an important actor", ***Expert, University Professor.***

Later, in 2011, a group of parliamentarians proposed to augment the 10% NCRE quota. The right-wing government in office did not sponsor the law this time, but it was possible to move forward with it anyway (despite Chile's presidentialist regime who gives priority to legislations sponsored by the executive power). A (non-formal) coalition formed by parliamentarians from the current opposition, environmental NGOs and NCRE industry associations resisted the strong opposition that conventional energy companies again raised, this time arguing that the intermittence associated to NCRE technologies, solar and wind in particular, introduced physical complications to the electricity grid that prejudiced the stable and constant operation of the electricity system, and thus they opposed the percent increase for safety and quality motives. Finally in 2013, Law Nº 20.698, called Law 20/25, was passed again with widespread support from congress (the left-wing coalition that represented the opposition at this time did a cross-negotiation with the government in office for passing this law). This law raised the quota previously established mandating that by 2025, 20% of the total electricity generated by big generation companies must come from NCRE sources (at the beginning the law draft proposed that 25% of the electricity generated come from NCRE source by 2025, but the proposed target was finally lowered to 20%). The executive representative of the Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*, ACERA) noted: *"we wanted the government to send the signal that there was a future in this, and that the participation of renewables continued to increase"*.

An important nuance of the Chilean transition case is its social character. As it was studied in Chapter 3, two key relevant social factors greatly determine the Chile's story. One is the push towards renewables' deployment that social organizations, mostly environmental NGOs and NCRE industry associations (acting as policy entrepreneurs), gave to the transition, taking advantage of the window of opportunity for socio-technical change that the occurrence of energy crises had opened. The other one is the strength that massive social movements and local communities raised against conventional energy projects, which prevented their development.

Other laws that less directly favored renewables' deployment were passed in the meantime. In 2012, the emissions' regulation for thermoelectric power plants was passed, which was another disincentive for developing coal power plants. Also in 2012, the government passed the so-called *Net-Metering Law* (Law Nº 20.571), which regulates the payments of tariffs for residential generation, establishing discounts and refunds when applicable. Unfortunately, the lobby on part of utility companies for the negotiations of that law was heavy, and the tariffs to be paid to residential generators are so low (around 40-50% of the price that utilities companies charge them) that do not really incentivize, for example, the installation of solar rooftops. The government is currently working on a new distribution law, for which it has received financing from the Inter-American Development Bank (IDB) in late 2016. In addition, a carbon tax was implemented in 2014 and intends to incentivize plant operators to invest in clean technologies to reduce emissions. It charges generators operating thermal plants with installed capacity equal or larger than 50 MW $5 per ton of CO2 released.

In 2014, by the time when the left-coalition regained office, the renewables' market was already starting to gain momentum, though several problems were slowing down development, most of them related to the ways in which the electricity market was structured and, related to that, to the financing options available for the new technologies. Among the most important problems was getting access to Power Purchase Agreements (PPAs) for developing projects. As the technologies were new and unknown, it was difficult for small developers to get contracts with the private sector, and given the variability and uncertainty associated to electricity prices, local banks were being increasingly reluctant to take the risk of financing projects that planned to sell their electricity in the spot market (an option that they had gingerly started to offer). Recognizing those limitations, renewables' developers identified the opportunity of selling energy to regulated costumers, which represent approximately 55% of the market. So far, they had been only able to sell their generated electricity to unregulated costumers, given the way in which electricity trade was structured in the country, which used to comprise the trade of fixed amounts of power. The ACERA association along with multiple developers in the sector lobbied hard for making a big change in the way public tender regulations were structured, so as to instead of trading constant amounts of power, companies were able to trade energy blocks hourly. This change meant that technologies that were able to generate electricity only during certain times a day, such as wind and solar PV, were now going to be able to bid in public tenders. That claim was finally heard when Maximo Pacheco become head of the Ministry of Energy, and the change was applied for the first time in 2014, even before the official law that implemented (which was passed just in 2015, Law Nº 20.805). So far there have been three rounds of those tenders, in 2014, 2015 and mid-2016. Importantly, the law also transferred the organization of public tenders for regulated consumers from the distribution companies, to the National Energy Commission. Thanks to the implemented regulation, energy prices have consistently and significantly dropped (price trends are presented in section 4.4.4), according to the Ministry and other experts, due to the increase in competition and the entrance of competitive NCRE technologies.

A combination of good conditions for the development of renewables resulted in a boom of NCRE generation projects, especially of wind and solar PV technologies, that took place between 2014 and 2015. Beyond the push that policy entrepreneurs exerted for renewables' deployment, the following are among the factors that contributed to the rapid expansion of the sector were: the availability of high-quality renewable energy resources, high energy prices, the fact that conventional energy projects faced strong oppositions from communities across the country, the increasing availability of financing, the existence of a stable regulatory framework, the commitments sustained by the government to continue to support renewables' deployment, promising energy demand expectations, and the improvements in efficiency, as well as the continuous drop in technology costs, especially of PV panels and wind turbines.

Soon after that the rapid expansion of NCRE projects started to take place, in the electricity system begun to increasingly experience transmission problems. Multiple nodes, especially in Northern Chile in the zone called Norte Chico, started to experience curtailment problems due to the high concentration of solar PV power plants that had proliferated in recent years, attracted by the high radiation levels of the Atacama Desert. Prices started to repeatedly fall to zero, as congestion in the network did not allow for the transmission of the overwhelming amounts of generated electricity (see Bloomberg, 2016). Meanwhile, the big consumer centers in the South had to continue to use much expensive energy generated from conventional energy sources, even though generation capacity from NCRE had surpluses in the north and other areas.

As a matter of fact, expansion projects in the transmission sector lagged far behind the rapid development of the generation sector, which has both caused transmission problems and slowed down generation investment. Transmission problems are attributed by some experts to the rapid development of the NCRE generation sector, which is characterized by much slower development time frames than conventional energy mega projects. Others accuse a lack of adequate planning on part of the state, in a sector that is essentially monopolistic. On top of that, transmission projects are further delayed by the increasing opposition from local communities and land-owners.

In 2014 the government started working in a transmission law that aimed to solve the urgent problems of the transmission sector. In July 2016 the so-called *Transmission Law* (Law Nº 20.936) was finally passed. This law creates a new electricity system unifying the two larger electricity systems in the country —the Central Interconnected System (in Spanish *Sistema Interconectado Central*, SIC), and the Norte Grande Interconnected System (in Spanish *Sistema Interconectado del Norte* Grande, SING), which together represent 99% of the electricity mix—. The interconnection expects to be ready in 2018/2019. In addition, the law establishes a new independent coordinating institution (new Load Economic Dispatch Center (CDEC) for the new interconnected SIC-SING system called *National Electricity System*) that will oversee the operation of the unified electricity system (called *National Electricity Coordinator*, in Spanish *Coordinador Eléctrico Nacional*) replacing the respective CDECs that governed each system before. Furthermore, the law also attempts to make improvements in the transmission sector's planning. From now on, the operation of the sector will be assessed every year by the new coordinator, which will make recommendations to new entrants and incentivize/dis-incentivize developments in certain zones. But, despite this planning component that will certainly be helpful for preventing future transmission problems, investment in the transmission sector will still be subject to private willingness to pursue it. With all, most stakeholders in the sector are positive that the law will solve the majority of the transmission sector's hurdles, particularly curtailment problems through the interconnection between the SIC and SING.

Though the transition has achieved positive results so far, there are multiple challenges for further developing the renewables' sector in the country. Many of those challenges have to do with modifications to the regulatory framework that the state needs to pursue, or represent a major policy task that the government is expected to lead. The main challenges identified by interviewees are the following:

The implementation of regulation for guiding the operation of ancillary services in the sector was announced several years ago (7 years approximately), which are to comprise the guidelines for the implementation of an ancillary services market. The regulation is still not ready though, and there are no signs that it is going to be available soon. The generation sector in general is widely interested in the development and implementation of this regulation, which is considered urgent and fundamental for variable technologies such as renewables to continue expanding in the country.

Experts and NCRE developers also think that if renewables are expected to penetrate the electricity market massively as the *Energy 2050* policy proposes, there is a need for changing the marginal cost system that Chile utilizes for ruling electricity trade in the wholesale market. This, as many NCRE technologies entail a cost structure that is different from the one that characterizes conventional energy technologies for which the marginal cost system was designed. Indeed, renewables generally require big up-front costs but at the same time are characterized by very low operational costs, in contrast to fossil fuel generation technologies which generally have more expensive operational costs. For these reasons curtailment problems bring along the problem of null (or negative) remuneration when renewable energy technologies fill the transmission capacity of a line, as it is happening in Northern Chile.

One of the additional problems that further renewables' penetration faces in Chile is social rather than technical, and it has to do with the social acceptance of generation projects. This is the case for the sector in general, though NCRE projects generally face less community rejection. In Chapter 3 we took a deep look at how generation developers struggle to get social acceptance for their projects in the tensed up environment that surrounds the sector at a national level. This is why companies have started adapting their business development models, with the NCRE sector taking the lead in this respect, and thanks to that developers perceived that NCRE projects have considerably increased their chances of managing conflict and moving forward with their projects. The private sector in general thinks that there is a need for more guidance from the government in this respect. The government has developed some general guidelines for developing projects in a more participatory way, but defining clear limits and obligations, both on part of communities and developers is still pendant. One of the interviewees noted:

> *"The private electric sector was asking the government for help with environmental and social conflicts, meaning that the private sector is sometimes overwhelmed by these issues, and the government has a role to play in solving them"*, ***Expert, University Professor.***

Related to this is the issue of the lack of a land-use policy in the country (in Spanish called *ordenamiento territorial*), which implies that generators decide unilaterally the location of a power plant, and they are able to realize the projects if they comply with the requirements associated for a project with certain specific characteristics. This raises a lot of opposition on part of local communities, and for that some institutions and scholars have raised the issue of a need for developing a well-defined land-use policy. The government has started to make some effort in this respect, but the sole visible result has been the inclusion in the new transmission law of a modest planning component that contemplates the definition of certain swathes of territory where transmission lines will be allowed to be installed.

4.3.3. Creation of institutions

Table 4.3. Chilean government's institutional structure.

Year	Government's institutional structure
2007	Separation of the energy jurisdiction department (National Energy Commission, in Spanish *Comisión Nacional de Energía*, CNE) from the Ministry of Mining.
2009	Creation of the Ministry of Energy.
2009	Creation of the Chile's Renewable Energy Center (in Spanish *Centro de Energías Renovables*, CER) is created for supporting renewables' deployment. This agency was part of the Chilean Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*, CORFO).
2010	Creation of the Chilean Energy Efficiency Agency (in Spanish *Asociación Chilena de Eficiencia Energética*, ACHEE).
2014	The CER is replaced by the Center for Innovation and Development of Renewable Energy (in Spanish *Centro de Innovación y Fomento de Energías Renovables*, CIFES).
2014	Creation of Regional Energy Secretariats (in Spanish *Secretarías Regionales Ministeriales*) throughout Chile.
2016	The CIFES is closed and the creation of the new Solar Industry Committee is announced.

Along with the design of policy documents and the approval of market regulations, the government created a series of institutions throughout the years for the implementation of policy measures. Some of those institutions were established explicitly for fostering renewable energy technologies' deployment, while others were part of the country's general shift in its energy policy strategy. The emergence of multiple institutions along the years reflects the fact that the energy sector became increasingly important in the country along the way of the transition —in part causing it but also caused by it—acquiring much more preponderancy than it used to have before.

The review of Chile's energy policy published by the International Energy Agency in 2009 notes with respect to the institutional framework at the time: "An assessment of Chile's existing institutional structure reveals a number of shortcomings: the difficulty of coordinating policies where interests are shared across a number of ministries, commissions and agencies, which is a particular problem in the case of environment and energy policy; the difficulty of gaining an overall view of the sector; a legalistic approach to the regulation of the sector to the detriment of long-term public policies; and the institutional weakness of the CNE in relation to other entities in the sector" (IEA, 2009).

Just in 2007 the energy jurisdiction department (CNE) got separated from the Ministry of Mining to become a governmental policy area on its own. In 2009, the Ministry of Energy was finally created to manage and oversee energy policy issues and strategies in the country. This change established a separation of functions between policy formulation (in charge of the Ministry), technical-economic regulation (assigned to the CNE), and enforcement (that was left in hands of the Superintendence of Electricity and Fuels, in Spanish *Superintendencia de Electricidad y Combustibles*, SEC).

Along with the above, also in 2009, the Renewable Energy Center (in Spanish *Centro de Energías Renovables*, CER) was created for supporting renewables' deployment, as part of the Chilean Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*, CORFO). This implementation agency played a particularly important role in facilitating the opening of the market for renewables in the country, which was the objective of the NCRE first quota law. The CER worked on different fronts, including offering (limited) funding in the form of grants to fund preliminary pre-investment feasibility studies —which was partly funded by the Germany's KfW Development Bank—, on attracting foreign investment, and helping national banks to learn about the sector and sweep away perceived risks in order to open financial options for the NCRE sector. Indeed, getting access to financing from national banks was only possible until later on, as the national financial sector was at first very reluctant to offer financing to new and unknown NCRE technologies. The first NCRE projects of wind and solar PV technologies were developed with support from multilateral development organizations, like the IDB, the IFC and the CAF, which set a precedent being the first in bearing the associated risk (that . national financing institutions were unwilling to take). Their role is widely recognized by stakeholders as key for opening the renewables' market in Chile. Importantly, loans were granted to private corporations, as the generation sector is privatized in Chile, and did not require sovereign guarantees. Support from the state on that side was limited to offer sponsorship when organizations required it.

It was not until around 2013/2014 that the national financial sector started to get seriously interested in offering financing to these new energy technologies, after witnessing the experience of many successful projects. By then, national banks started to offer project finance schemes (before the only option were corporate finance schemes), in part as the result of the training programs and lobby that CORFO had done. At first banks were willing to fund projects that were going to be financed selling energy to the spot market at spot prices, but when curtailment problems started to occur, banks were not willing any more to bear the risk associated to the variability and instability of spot prices, and stop funding projects that did no have PPAs. The case of small hydropower generation plants was a bit different as banks have had experience with large scale power plants, but they were reluctant to finance those projects anyway, doubting about the profitability of smaller plants and not being used to (new) entrants other that traditional companies.

CORFO also implemented other programs, all of them quite brief and moderate in reach and scope, for incentivizing renewables, including low-interest loans for renewable energy investment (launched in 2008 and co-financed by the KfW, loans for refinancing long-term credit and leasing operations for investments contributing to environmental improvements), capital guarantees and risk capital funds (only introduced in 2009 for both self-funded and CORFO-funded projects), and clean technology fund (CTF) (designed to address key risk, cost and liquidity barriers by providing concessional financing and technical assistance intended to stimulate the development of the country's solar power and energy efficiency markets). A detailed list of all financing programs implemented by CORFO can be find in the study developed by Carlino (2016). With respect to the role that CORFO played along the years, interviewees reported that:

*"They started to make information for the sector available and it was credible information, then I think that that probably encouraged investors, that would not have ventured if there had not been transparency in the information", **Executive representative of the Renewable Energy Association**.*

*"There was an important role by multilaterals and also an important role played by CORFO. CORFO established a credit program, CORFO program of renewable energy for banking, so that banks were able to access relatively low fund costs for lending to projects on renewables. I think that was also helpful but it was too short, short lived, and the funds were scarce too, but it jumpstarted the first projects. The first projects were minihidro, there were no solar nor wind powered projects participating in these funds …", **Financial sector executive.***

Currently, CORFO has also lobbied for attracting several research institutes to Chile, to work on renewable energy science and innovation. Among them are the Center for Solar Energy Technologies, which expanded the role that the German Fraunhofer Institute was doing in Chile, the Belgian LABORELEC energy research center and the French Marine Energy Research and Innovation Center MERIC.

In 2010, though not in direct relation with renewables' development but in line with the general policy vision that the country was developing, the Chilean Energy Efficiency Agency (in Spanish *Asociación Chilena de Eficiencia Energética*, ACHEE) was created, though the policy area has not had an agile development as the NCRE has had in recent years.

In 2014, when the left-wing coalition regained the presidency office, the CER got replaced by the Center for Innovation and Development of Renewable Energy (in Spanish *Centro de Innovación y Fomento de Energías Renovables*, CIFES). This reflected a change of focus of the ministerial vision, which wanted now to foster renewables as an innovation and entrepreneurial sector in the country. Later in 2016, the CIFES was decided to be closed, and the ministry announced the creation of a new Solar Industry Committee for replacing it. This change is part of a new strategy that the country is adopting, which focuses on incentivizing the solar industry as a central economic sector for development. Indeed, the government sees the Atacama desert as a unique asset that offers comparative advantages for the country, and might offer the possibility of exporting solar energy. Multiple efforts are being put forth for advancing the solar sector, including R&D funding for innovation, as well as entrepreneurial support for developing a local solar industry that so far does not exist (almost everything is imported). More than the development of new technologies though, new strategies are oriented towards the adaptation of existent technologies to the particular conditions of the Atacama Desert, where the zones of major solar radiation are located. Though efforts are valuable, foreign experts seem to coincide in thinking that this might not be an appropriate niche to put all efforts in, especially given China's strong leadership of the sector. Many of them think that Chile should focus on a much less developed technology that might offer both comparative advantages and less strong competition, as it is the case of marine energy. With respect to the development of marine energy technologies, different interviewees reported that the Chilean government has at least a couple of times discarded opportunities for the sectors' development, including a loan from the IDB that the right-wing government had negotiated and was discarded when the left-wing coalition regained the presidency, and a loan from UK-related sources that aimed at investing in the development of marine technologies in Chile.

There have also been other institutional changes that are tangentially related to renewables' deployment. Among them was the creation of the Regional Energy Secretariats (in Spanish *Secretarias Regionales Ministeriales*) throughout Chile in 2014, which reflects the increasing importance acquired by the energy sector in the country and also an effort for starting to decentralize it.

Also in 2014, the Ministry of Energy created a unit to be in charge of advancing participation and dialogue with communities. The unit is now the Division of Participation, and currently focuses on three main areas: (i) on improving participation mechanisms related to consultation processes with communities in the context of energy matters, (ii) works on issues related to the development of a land-use policy (*ordenamiento territorial* in Spanish), which the country currently lacks, and (iii) on addressing issues and necessities of indigenous communities. Their pioneer work is just starting and there is still a lot to learn in all fronts, but though their role has raised some skepticism and critiques, they represent a new way of doing policy in Chile, and their effort is valued widely among stakeholders in the sector.

Notably, Chile has received support from different countries, especially Germany, on its endeavor for advancing renewables' deployment. Germany has provided support to Chile on energy matters since the late 1990s, through the German Society for International Cooperation (GIZ). The GIZ has worked close with the government offering guidance and support on renewable energy and energy efficiency related programs, including the exploration and mapping of the country's renewable energy potential and on helping programs for training workers, and they have offered constant advice with regard to sustainability and energy policy matters. In addition, Germany's KfW Development Bank has also lent loans for financing renewable energy projects. Though in a more modest way than

Germany, the US has also supported Chile through the US Department of Energy and the US National Renewable Energy Center, who helped launch and offered assistance to the CER (which lately become the CIFES) (US ITA, 2013).

4.3.4. Transition's outcomes

Carlino (2016) concludes his study of the financing options available for renewable energy projects in Chile (elaborated by request of the IDB), noting that "…renewables have become to play an important role in the primary energy consumption… […] for that it has been key the integration of an adequate political, legal and regulatory framework, a good environment for investments, an outstanding potential in renewable resources, and the establishment of targets for NCREs' participation in the energy mix. These elements create the necessary conditions for the deployment of diverse investments...". This speaks about the positive impression that observers have about Chilean policies. Quantitative figures seem to back up this positive impression. The following graphs are presented for providing a big picture of the overall outcomes of the transition.

Figure 4.1 shows the evolution of the installed power generation capacity from 2005 onwards. On the graph it is possible to observe how NCRE projects start developing after 2008, when the first quota law was passed. Wind farms begin to appear mildly around 2009, though they mostly develop after 2011, while solar energy (mostly photovoltaic) starts to develop in 2012. The graph also shows the boom experienced by wind and solar PV generation technologies in 2014 and 2015. Small run-of-river plants started to be developed earlier, around 2005 and continue to develop incrementally in the following years.

Figure 4.2 shows how electricity generation projects under construction have evolved over time, making apparent the impressive shift from conventional energy technologies to NCREs started to become stronger after 2011.

Figure 4.3 illustrates the evolution of electricity generation projects that obtained environmental approval Environmental Qualification Resolution (in Spanish *Resolución de Calificación Ambiental*, RCA) across the last decade, and the type of energy source they were using. The graph also shows the investment associated to each type of project, however, these figures are approximated and correspond to the quantities that were declared by developers to the Ministry of the Environment for getting approval of the environmental resolutions associated to the projects, and then not all of them were finally developed, while others are still on hold.

Figure 4.4 shows how the obligation imposed by the quota law has been accomplished and surpassed over the years. This issue was pointed out by several interviewees, with many of them arguing for the need of a more ambitious target that further pushes the transition.

Figures 4.5, 4.6 and 4.7 depict the evolution of electricity prices during the transition, evidencing how electricity prices have started to drop significantly as the entrance of new NCRE actors to the generation market has created more competition, as the government and experts have declared (Finat, 2015). Figure 5 shows the price offered in electric power tenders held by the government have dropped over the years. Moreover, in the last public tender held in July 2016, nominal prices dropped even more reaching 47.6 US$/MWh (Diario Estrategia, 2016). Figure 6 shows how average marginal costs have also been dropping in both the SIC and the SING. Figure 7 further illustrates the dropping tendency of prices, showing how short-term node prices arecalculated by the CNE. The node energy price is the average over time of the marginal cost of energy in the electricity system operating at the minimum, updated operation and rationing cost. In the case of SIC, it is also considered in the calculation, a set of possible hydrological conditions for pricing horizon evaluated.

Figure 4.8 shows transmission lines under construction (SIC+SING) in km by March 31st 2016 (Pacheco, 2016). The data was retrieved from the Environmental Impact Assessment System (in Spanish *Sistema de Evaluación de Impacto Ambiental*, SEIA), which indicates that, by the end of March last year, there were 35 transmission projects under construction that corresponded to a total of 2,021.1 km (Additional transmission 722.7 km; Sub-transmission 151.4 km; Trunk transmission 1146 km), representing an approximate investment of USD MM 1,543.39.

Overall, quantitative data indicates that a transition towards the use of renewables have started to occur in the last decade in Chile, which seems to have begun and increased after diverse factors have aligned for enabling socio-technical change to start taking place, in particular all governmental policies implemented across the years. The next section analyzes the collection of government policies that was just presented in this section, to explore in which ways they are likely to have contributed to outcomes obtained so far.

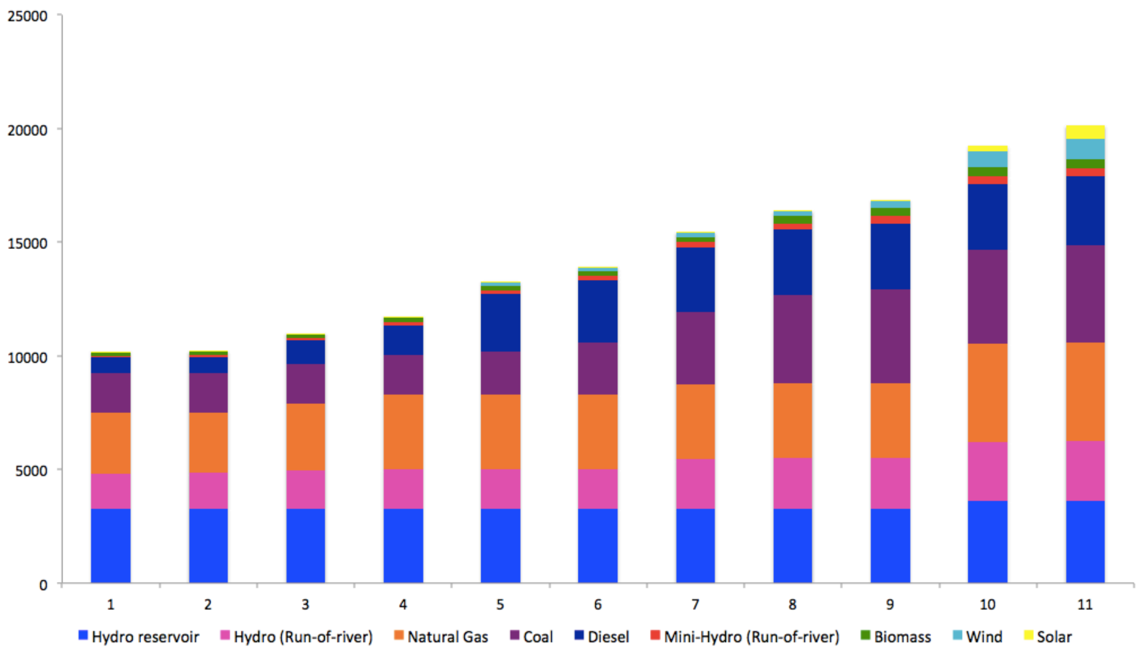


Figure 4.1. Evolution of the installed power generation capacity in Chile by year and by technology in MW. Data retrieved from CDEC SING and CDEC SIC.

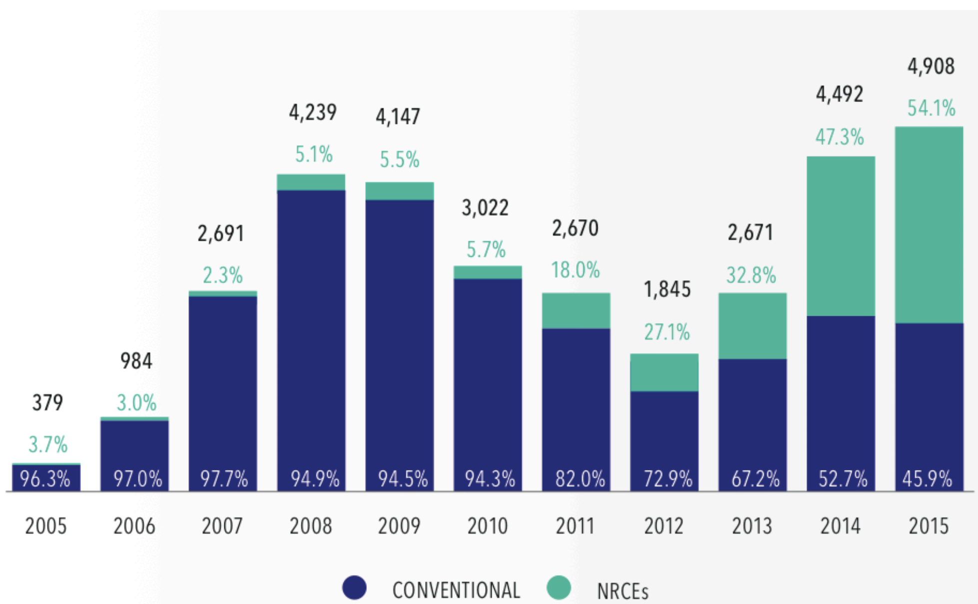


Figure 4.2. Expected operating entrance year evolution of the electricity generation projects under construction 2005-2015 in MW. Source: CNE (2015).

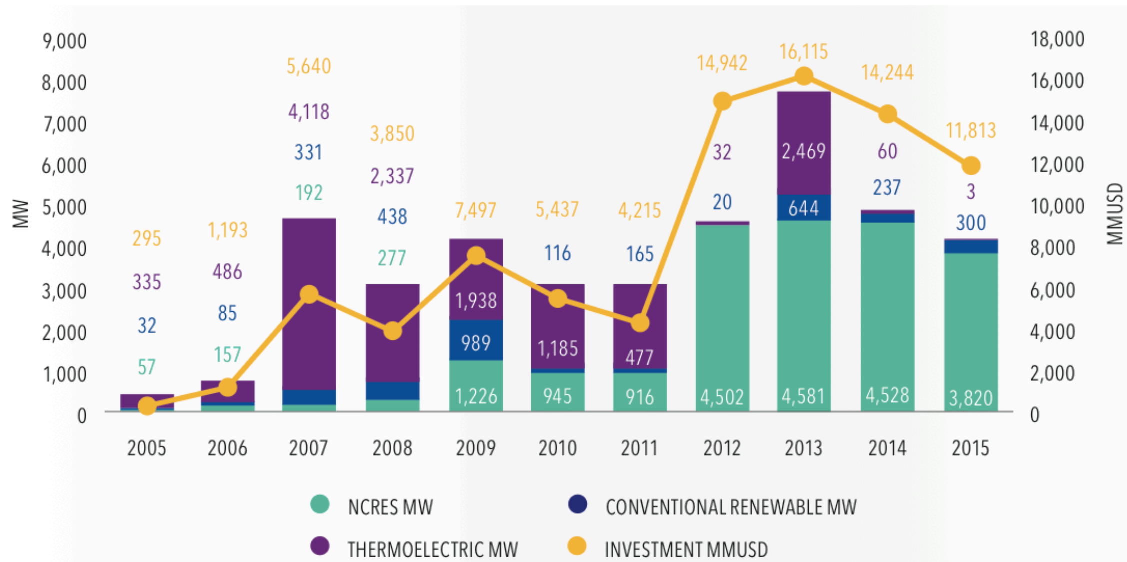


Figure 4.3. Evolution of RCA approved generation projects in MW and MMUSD. Source: CNE (2015), data source *Sistema de Evaluación de Impacto Ambiental* SEIA.

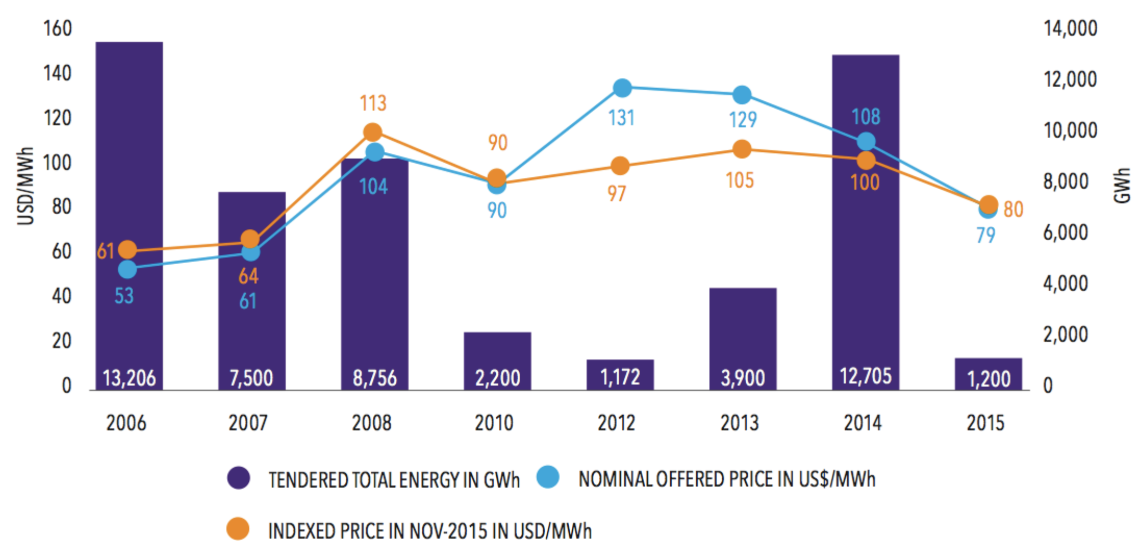


Figure 4.4. Evolution of prices offered in electric power tenders. Source: CNE (2015).

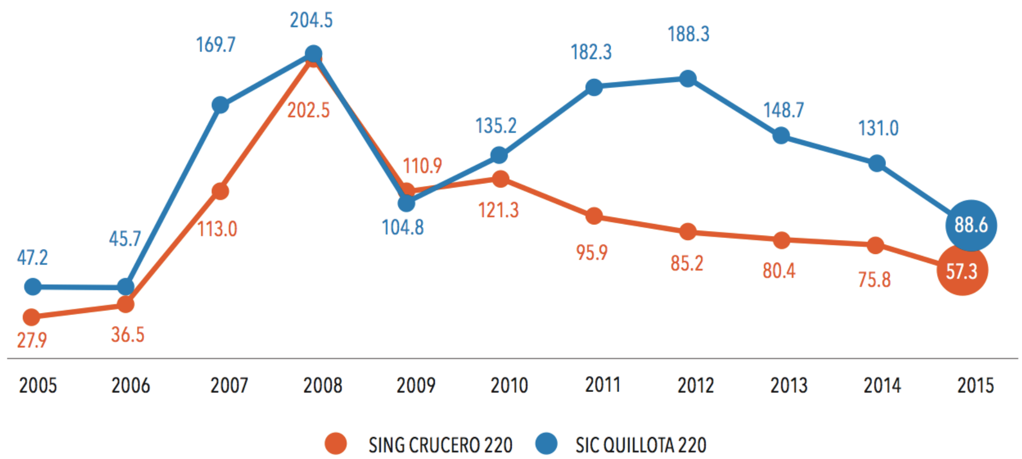


Figure 4.5. Average marginal costs evolution between 2005-2015 in USD/MWh. Source: CNE (2015), data retrieved from CNE, CDEC SING and CDEC SIC.

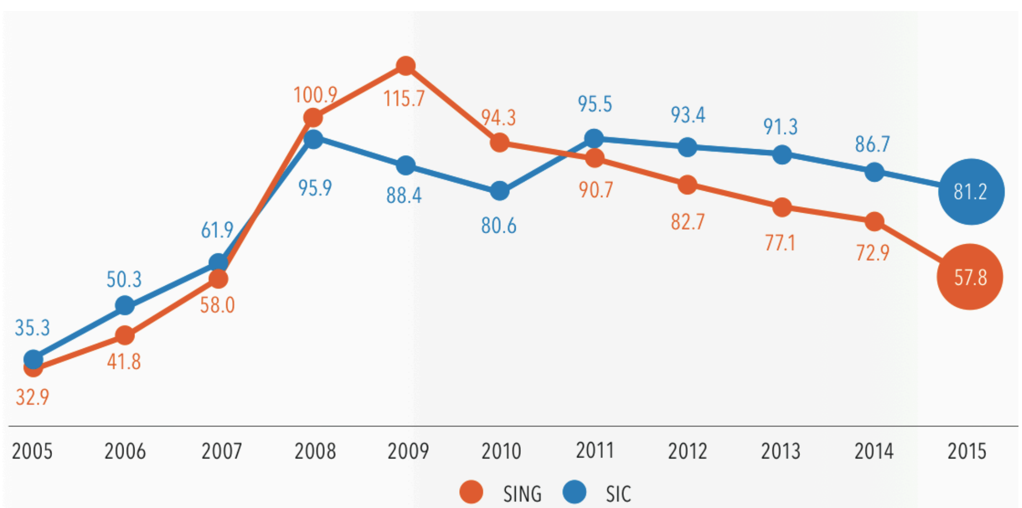


Figure 4.6. Short-term node energy price evolution between 2005-2015 in USD/MWh. Source: CNE (2015)

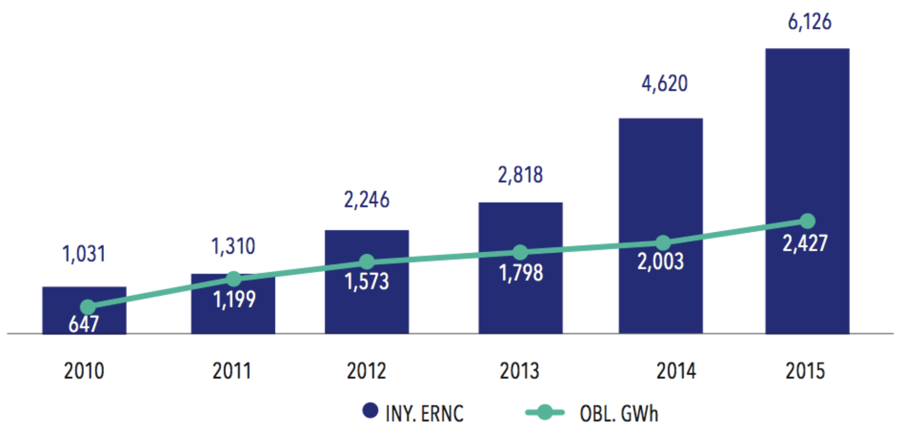


Figure 4.7. Evolution of NCREs power production recognized under Law Nº 20.257 in GWh.
Source: CNE (2015), data retrieved from CIFES.

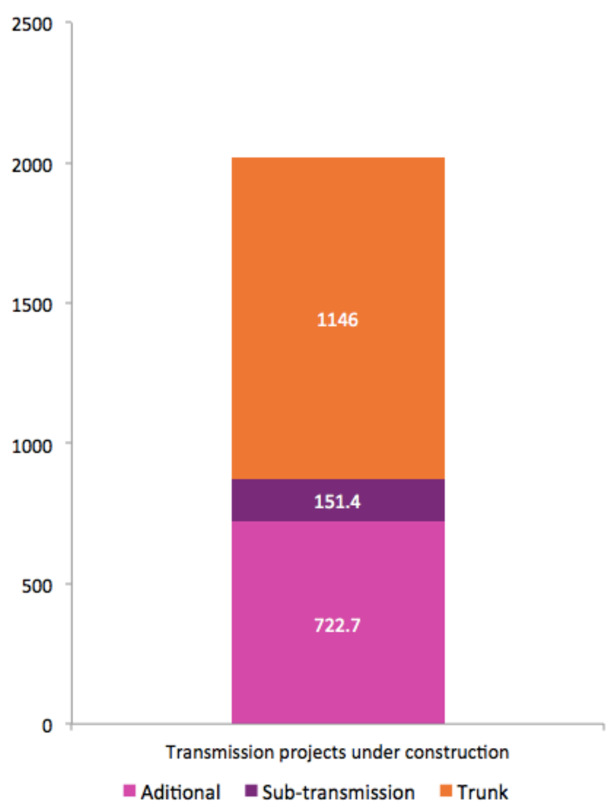


Figure 4.8. Transmission projects under construction (SIC+SING) in km.
Source: Pacheco (2016), data source *Sistema de Evaluación de Impacto Ambiental* (SEIA).

4.4. Analysis of the role that the Chilean government played in the transition

This section analyzes the multiple decisions and actions that the Chilean government took from 2004 onwards that contributed and in great part enabled (as we shall see) the shift towards the use of renewables that started to happen in Chile in the last decade. Importantly, though the Chilean electricity transition did not comprise the development of new technologies, it did involve an innovation component in the sense of the implementation of new technologies that were (practically) not present in Chile before and whose use needed to be adopted and diffused in the country. I argue here that the different functions that the government performed enabled the formation of a market for renewables in the country, and that the need for steering the electricity sector towards desired societal needs seems to call for a certain degree of planning and regulation, as we may observe from Chile's story (as well as from other countries' experiences).

4.4.1. A long-term energy policy for Chile

After Chile's electricity sector was liberalized and privatized during the dictatorship in the 80s, the country adopted a (deregulated) market approach as its overall energy policy strategy. But when facing important energy crises, including the gas conflict with Argentina 2004, as well as severe drought cycles, the Chilean reliance on a purely market strategy proved to be insufficient. This is how the government started to recognize the need for steering the electricity sector towards socially desirable objectives, a necessity that emerged as an empirical lesson learned from repetitive critical situations. Years later, the *Energy Policy 2050* document made this inference explicit: "When the energy sector develops through market solutions, this does not always lead to decisions that maintain the common good or prioritize society's preferences with regard to how best to use this essential resource. Chilean society expects the State to play a role in planning and management that includes all stakeholders in the definition of a solid and consistent market-oriented strategy" (Ministry of Energy, 2015).

The IEA (2009) report that assessed Chile's energy sector in 2009 noted that Chile's electricity liberalization reform has been hailed as a successful example for the reform of electricity sectors around the world, noting that "This [liberalized] model has supported Chilean economic growth over the past 20 years with continuous, private sector-led expansion of generation capacity, as well as of transmission and distribution networks, and has achieved almost universal access to electricity in rural areas. Access to electricity nationwide increased from 62% in 1982 to 98.5% at the end of 2008". The report adds that despite these benefits the multiple crisis episodes that Chile has faced have shown that security of supply is a basic requirement of a well-functioning energy market and that the state should play a forward-looking and coordination role in the design of energy policy. Furthermore, it emphasizes that the Argentinian crisis also showed the necessity for a systematic evaluation of the risks involved in the long-term provision of energy. The report also notes that in Chile there was a broad consensus at the time (2008) on the essential role of the state in guiding the evolution of the energy sector and in ensuring energy security and emergency response. And as they note, "this consensus acknowledges that energy security is a public good, which requires a unified, strategic analysis process" (IEA, 2009). Von Hatzfeldt's (2013) argument follows the same line; when assessing in 2013 the country's policy needs for a transition to renewables: "the state must show a strong political commitment to introducing concrete reforms that will improve the regulatory framework and incentive structures, create a serious penalty system, and take into account long-term economic, environmental, and social concerns". In the same vein, Prieto and Mackenna (2014) noted "It is almost unanimously agreed that Chile lacks a clear, certain and comprehensive vision of the energy sector. This has affected investments in energy infrastructure and, consequently, competitiveness, innovation and productivity, which, in turn, have directly affected growth. Therefore, we need strategic Government support, a consistent and integrated long-term energy policy and legal framework in order to generate, transmit and distribute electricity in a safe, environmentally-friendly and economic manner".

Along with the need for having a policy strategy that allows for guiding the energy sector towards desirable outcomes —greater economic efficiency and energy security in particular—, the idea of fostering electricity generation from renewables emerged as an option for the country's energy dependency problem. From the first energy policy draft that was published in 2008, renewables started to be seen by government officials as a serious alternative energy source. Since then, all the national energy policy drafts published in subsequent years included an important component of renewable energy. And even though at the beginning this policy design process did not aim at fostering a sustainability transition —which is something that we cannot factor out from this analysis—, it evolved towards incorporating formal sustainability goals as a core pillar of Chilean energy policy. The *Energy 2050* report states "…the Energy Policy is sustained by four pillars: Quality and Security of Supply, Energy as a Driver of Development, Environmentally-friendly Energy, and Energy Efficiency and Energy Education" (Ministry of Energy, 2050).

Importantly, there are certain characteristics of the policy development process and the political circumstances of the country that are likely to have helped a great deal in consolidating the vision that Chile slowly adopted towards renewables and have to do with the means through which the vision of NCREs gained legitimacy. It is to be said that in Chile, the transition to renewables was in great part driven by social organizations' demands (including environmental NGOs and NCRE industry associations, see Chapter 3) and was further boosted by the wide rejection that fossil fuel technologies arose in the general population, with renewables emerging as a natural alternative. Furthermore, when policy conversations about the future started to take place, many were organized by civil society organizations and attended by multiple stakeholders in the sector, including the government (see for example the *Escenarios 2030* initiative or the CCTP initiative). Afterwards, when the government that is currently in office started to plan for the development of the current energy policy (*Energy 2050*), it was necessary and natural to invite stakeholders to participate on the project, and to try to develop a strategy that integrated multiple visions for making it "socially valid".

I argue that the Chilean transition process exhibits an increasing pattern of policy design instances that respond to the need of steering the electricity system into a desired direction. From the beginning of this policy development process in the Chilean energy sector, renewables were seen as part of the solution to the energy needs of the country and were increasingly conceived as a central part of Chile's energy strategy. The development of a legitimate vision that considers NCRE sources as a center piece was then a first step towards the opening of a space for renewables in the electricity market, which have inspired and guided the direction that the energy policy sector in the country has started to pursue.

4.4.2. A new regulatory framework

Several regulations were passed for implementing the strategic plan that was envisioned for the country. A crucial part of those policies was the role that renewables were to play in Chile's energy and electricity mix, this is why several of the laws and regulations aimed at the creation of a space for renewables in the electricity market. Since mid last decade, Chile has tended to increasingly incorporate regulations in the electricity sector, with some of them explicitly aiming at renewables' deployment, while others were more focused in organizing the energy sector in general, affecting more tangentially NCRE technologies' development.

Back in 2008, when key government officials at the time decided to sponsor the first NCRE quota law before Congress, they did so with the conviction that such economic scheme was going to be able (and enough) to open a market for NCRE in Chile, expecting that afterwards, —given technology price expectations and energy prices in Chile—, NCRE technologies soon enough were able to compete by themselves in the market. The decision was made after balancing their objectives as well as the general political context in Chile, considering that the implementation of subsidies was really difficult to justify given the country's neoliberal economic approach plus its other multiple priorities as a developing country, and fact that the development of these technologies has already been subsidized in Europe.

The approach followed in the Chilean case is in line with the argument advanced by Kuzemko et al. (2016) who argued that political context matters and defines the policy options that are plausible in a country for implementing transition policies. They argue that "change is differential precisely according to the variety of ways in which embedded institutions and indigenous energy infrastructures inter-relate with forces for sustainable change and for continuity." In the same vein, they point that countries that lack energy fossil fuel resources seem to be more likely to develop an energy vision associated to renewables. They note "…some countries without, or with less access to, indigenous fossil fuel resources have longer histories of making their energy systems sustainable. Some scholars note that oil importer countries, such as Germany, Sweden and Denmark, responded more strongly to the 1970s oil shocks, partly by making their economies more energy efficient but also by starting to encourage renewable energy generation" (Kuzemko et al., 2016; Giddens, 2009; Di Lucia and Ericsson 2014).

Obtained results show that the first quota law accomplished its intended objective of starting to open a market for renewables in the country. After that, the second quota law was passed, this time pushed forward by a group of parliamentarians, environmental NGOS and NCRE industry associations. This law reinforced positive expectations and further consolidated the vision towards renewables' implementation that was being developed in the country.

A more recent step was the change in the public tender regulation that took place in 2014, which allowed renewables to enter the regulated consumers' market to compete for contracts with incumbent companies. Though the change is too recent to appreciate its effect on the national electricity mix, the law has certainly allowed the NCRE market to continue to grow, giving renewable' developers more access to contracts and financing options. Importantly, this specific change was the result of heavy lobbying on part of the NCRE industry sector, who recognizes the ability of the current government in office to hear and welcome their demands. One of the directors of the ACERA association commented:

"As the [NCRE] private sector we associated through ACERA, aligned objectives and talked to the government, and the government welcomed our demands and implemented reforms without promoting any specific technology, and I think we gained with that that all the education and thrust building process on renewables was quicker", ***Director of the Renewable Energy Association***.

Indeed, the current government is recognized also for making efforts to address the multiple smaller regulatory changes that the implementation of the different NCRE technologies has required for moving forward. Interviewees commented:

"The government has played more than an important role, it has been the main author [of transition changes]… […] Collaboration between the state and private sectors has been essential … especially for such a new and emerging industry, with regulations that needed updating; all eyes are set on the government to see if there is the political will to move forward with this industry …", ***CEO, NCRE private sector***.

"I think that governments have had a fundamental role, because traditional electric industry was being over-cautious about these new technologies...", ***Expert, University Professor***.

Moreover, stakeholders in the sector seem to widely recognize the positive role that governmental policies have had on electricity prices. Indeed, the drop in electricity prices generally is attributed to the increase in competition that the entrance on NCRE has implied. Despite positive efforts, interviewees also criticized the fact that the government has always had a (slow) reactive attitude with respect to the transition, meaning that generally it was not the state who proposed the changes and took a leadership role for advancing renewables' deployment in the country, but rather that role has been mostly undertaken by policy entrepreneurs, as described in Chapter 3.

The latest changes have been in the realm of transmission, as the literature foretells. The transmission law recently approved in mid 2016 was targeted to solve the general problems of the transmission system, but it is also instrumental for enabling further renewables' deployment. The law is expected to solve the majority of curtailment problems that have affected Chile's electricity systems in the last years due to the quick proliferation of solar PV plants in the Atacama Desert, as well as of wind farms in certain northern and southern nodes. The transmission law not only comprises an interconnection between the two main electricity systems in Chile and the creation of an independent dispatch organization for coordinating its operation, but also incorporates an important planning feature. In order to prevent future incoordination, the dispatch center will assess much more frequently the transmission system, and will submit recommendations to the CNE on preferable and less-preferable locations for generation investment. Additionally, the state will define (at least broadly) certain areas were expansions of the transmission system might be installed. With all, it is important to emphasize that still decisions on generation investment will remain in hands of the private sector, as well as decisions on whether to pursue investment in transmission lines. Despite its flaws, the law adds an important planning component to the electricity system, which is expected to represent an improvement from the blind independent market decisions that have driven it so far, enabling the state to gain a much more systemic view of the sector's operation. With respect to the planning role of the state, two interviewees from the private sector commented:

"[on energy transmission] it was necessary that the Chilean state handled the planning and helped solve the problem of how to properly do the transmission, in an inclusive manner … with a long term view …", ***CEO, NCRE private sector****.*

"The rationale in public policy has been to increase the role of the state… with the state being able to do planning and to steer the Chilean energy sector in order to achieve stability, not to nationalize it…", ***Representative of distribution and transmission companies, private sector****.*

I argue that the legislation passed by the Chilean government enabled the creation of a protected space that allowed NCRE technologies to start developing while shielded them from the selection pressures of the market (this will be further discussed below). The creation of the NCRE market was possible by increasingly implementing electricity regulations. Indeed, the Chilean case offers a privileged starting point for the study of this pattern, as regulation measures started to be implemented 2005 when the electricity market was fully liberalized. Even though not all regulation measures have aimed explicitly at introducing renewables' into the market, their development is intertwined and form part of the same evolution process of Chilean energy policy. I observe that in the Chilean case, the succession of events depicts a clear need for increasing regulation and planning, a need that arose as a consequence of the fully liberal market character of the Chilean energy policy approach, that was not yielding desired results neither in terms of energy security and efficiency, nor in terms of environmental sustainability.

Comparing the Chilean case with other cases

The need for more energy security and economic efficiency (and later on also sustainability reasons) pushed Chile to back off from full liberalism in the electricity sector, in particular for boosting renewables' development in the country, in order to diversify its energy mix. Arguably, the case of Chile is similar in this respect to the cases of other countries that once had liberalized their electricity sectors, but have also shown a tendency towards implementing increasing regulation for being able to steer the electricity sector towards a desired direction, in particular, for fostering renewables' deployment. The UK is an interesting example for comparison, being a country that was once a recognized icon of electricity market liberalization. In 2011, the UK government announced an electricity market reform that included multiple regulation measures implemented with the aim of steering their electricity system to achieve environmental targets (Pollitt, 2012). The UK policies for incentivizing renewables included feed-in tariffs and the so-called ROs, though recently the country has substantially started to reduce renewable energy support programs. In the US, California decided to back up from liberalization in 2001 due to misconduct and manipulation on part of the private sector. Shortly after backing up from deregulation, California decided to set ambitious renewable energy targets and implemented a renewable portfolio standard scheme. Even in Texas, an RPS scheme was introduced in 1999 mainly supported by job-creation reasons. Western and Nordic European states show a similar pattern, though their examples are perhaps less illustrative as they generally corresponds to countries that are more favorable to state intervention in the market than more capital economies that follow more liberal economic principles, as it is the case of Chile. Overall, when contrasting the experience from the aforementioned countries with the Chilean case, it seems clear that regulation is needed for steering the electricity sector towards the development of desirable outcomes, in this case, the development of renewable energy markets. There is though, a difference between Chile and the rest, and is the fact that Chile did not implemented subsidies for fostering renewables deployment, but it is also widely recognized that that was the case as Chile implemented technologies that were “mature” and whose development had been already financed by developed countries. In any case, even when prices where skyrocketing and Chile had an attractive environment to do business, the push that was implemented through the quota law proposed by the state is deemed as necessary for opening the market for NCRE technologies.

Beyond the policies that these different states have implemented for correcting price barriers, all of them have needed to implement transmission reforms as well. Several reforms in the UK have been enacted for incentivizing the expansion of the transmission system (while keeping prices low) and for improving transmission planning. The state of California started planning early for the transmission needs that the state’s renewable energy targets were going to require. The state set plans of annual revision and there have been additional review rounds (RETI and RETI 2.0, see section 4.2.3). Thanks to these planning strategies, California has been able to plan ahead and has suffered only modest curtailment problems. Texas also faced multiple transmission problems after the boom of wind projects that has taken place during the last decade. In 2007, the state decided to inject support for developing a transmission expansion. Since the development of the expansion was not planned ahead enough, the state faced multiple curtailment problems that finally started to diminish when the expansion was ready in 2013. Moreover, in light of experience, the FERC issued order 1000 requiring mandatory coordinated planning for grid investments that affect multiple states and utility jurisdictions. Like Texas, in Chile the gap between generation and transmission development has caused multiple problems, which are now trying to be addressed through the transmission law, that incorporates an important planning component. In line with the literature, the Chilean case supports the argument that transmission planning is particularly vital for further enabling the development of the renewables’ sector. Indeed, implementing electricity market regulation not only allows for steering the system towards desired societal outcomes, but there is also the economic reason of enabling the system to operate in a better way.

Experience shows then that fully liberalized electricity sectors do not tend to guide markets in desired societal directions, or at least not in the pace needed. The need for steering the system into a desired direction, in particular for the boosting of renewable energy technologies, then speaks about the necessity of incorporating policy (regulation) and a planning component in socio-technical energy systems. In that sense, while liberalization and competitive markets do offer benefits such as incentivizing investment from the private sector and allowing competition, there seems to be a need for steering through regulation the direction that the system is taking so it is possible to orient it towards desirable societal needs and thus finding a balance between both is indispensable.

Lessons learned

In sum, the legislations and regulations implemented by the Chilean government contributed in great manner to the shift towards renewables that the country has started to experience, by enabling the entrance of NCRE technologies and by protecting their early development. I argue that, as many interviewees noted, without governmental support —including the first quota law, the change in the public tender regulation and the transmission law—, the development of a renewable energy market in the country would not have started as early as it did, and might have not started at all. Moreover, I argue that Chilean policy has exhibited a pattern of increasing regulation (starting from full liberalization) that has been key for the development of renewables in the country. Indeed, the Chilean experience and the experience from other countries as well seem to suggest that fully liberalized electricity systems do not deliver the expected optimal results for society, neither do they allow countries to guide the electricity sector towards a desired objective. In that sense, there is a need for having a certain degree of regulation policy and planning in the sector that balances what fully liberalized systems lacks, such as allowing for steering them towards desired societal outcomes.

4.4.3. Institutional supporting infrastructure

For implementing the market regulations and policy strategies designed for the achievement of the envisioned long-term goals the Chilean government had to restructure existent and to add new institutional capacity. Multiple institutions were created, which evolved and/or got replaced along the years. Again, not all institutions were exclusively created for the development of the renewables' sector, but they were certainly part of the transformation process of the government's approach with respect to energy policy and planning that integrated NCRE technologies as a core pillar from the beginning.

Governmental organizations and programs have been created covering three areas: policy design and overall coordination, implementation agencies, and regulatory agencies. In 2010 the Ministry of Energy was created to be in charge of policy design and envisioning, as well as for overall coordination. This event in particular illustrates the preponderance that the sector acquired in the country over the recent decade. Along with that, CORFO committees were created (the CER which later became the CIFES) for supporting investment in the sector. The programs implemented by CORFO committees did not include massive amounts of funding for projects' development (as they only offered modest amounts for pre-investment feasibility studies), but they offered complementary functions that further contributed to the development of a market for renewables. Implemented programs included studies about Chile's energy potential and guides about the operation of the Chilean electricity market which helped raising and diffusing information. They also promoted foreign direct investment in Chile's renewables sector through multiple international campaigns. And in line with that, they worked constantly for facilitating access to financing for NCRE projects, offering support for projects before multilateral organizations for accessing loans and helping the national private sector to understand the new technologies for dissipating the risks associated to them. Then, though very moderate in scope and reach, CORFO policies did play an important supporting role for the transition. However, the role that implementation agencies are to play in transition processes that would involve local development of technologies is likely to be much more aggressive and supportive.

The government also created and restructured regulatory organizations during the last decade, including the CNE and the Load Economic Dispatch Centers (CDECs). Though such institutions did not focus directly on renewables' deployment, they were aligned with the government's goals in that respect and contributed to shape the regulatory framework for renewables' advancement, especially in terms of technical protocols and implementation requirements.

From the Chilean case it is possible to observe the development of institutional capacity on part of the Chilean government for the implementation of the energy policy strategy and the related market regulations. In fact, the Chilean story shows explicitly how institutions were created, replaced and reformulated for both supporting the organization of the energy sector and in particular for pushing the development of NCRE electricity generation. Interviewees' testimonies argue that the role that the created agencies have played so far has significantly contributed to the deployment of renewable energy technologies in the country. In line with that, the literature on environmental policy highlights the importance of counting with the adequate institutional capacity for implementing environmental policies. Additionally the literature on transitions also assumes the creation or re-structuration of governmental institutions for enabling a transition to develop. The Chilean case reiterates the importance of counting with adequate institutional capacity for the implementation of policies and market regulations that lead to transitions' change, which constitutes a fundamental part of the role of governments in fostering transitions. This highlights the additional effort that will be needed on part of developing countries that currently do not have the adequate level of institutional capacity, which they will necessarily need to develop.

4.4.4. A new market for renewables

The Chilean transition does not correspond to a case of sustainability transitions management, as it did not follow any pre-defined strategy that lead to the development of the renewable energy field in Chile, neither it started as an intentional shift towards more sustainable energy practices. The electricity transition that has started in Chile have not involved either the development of new technologies, which is one of the key developments that transition theories aim to push, though it has comprised the adoption and diffusion of new technologies. In that sense, theories on technological innovation (from the sustainability transitions research field) are useful for analyzing the Chilean case, as they intend to explain technological (development and) diffusion processes. I argue that, the actions that the Chilean government has undertaken have been key for enabling a progressive transition in the electricity sector, and that such actions cover multiple aspects that are identified as key features by technological transitions theories, namely TIS and SNM.

The TIS approach is intended for the analysis of development process of a single new technology. The Chilean transition comprises the development of a group of NCRE technologies, with almost no policies being dedicated to a specific one, but I argue that the general features that the TIS theory identifies as key for an innovation system's development also apply and are adequate for analyzing technological development in a more general way. The TIS approach indicates that the development of a technological innovation system —that is, a network of actors and institutions for the development, diffusion and use of a new technology— involves a formative phase and a growth phase. We might say that the Chilean transition has so far navigated the formative phase for the innovation system that comprises jointly wind farm, solar PV and small run-of-river power plants, and the transition is arguably initiating the growth phase now.

The formative phase comprises four key elements that allow technology markets to start developing: institutional change, market formation, new entrants, and advocacy coalitions. The Chilean government performed functions that influenced and enabled each of those four elements. The different policies, regulations and activities touch on multiple of the identified four aspects, which are not clearly defined but are rather intertwined between each other.

A first characteristic of the formative phase is the presence of institutional change. This comprises changes in development policies for fostering technological innovation and also changes in the institutional framework that allow the diffusion of new technologies. The Chilean transition exhibits important institutional changes that involve changes in regulations, as well as in the organizations of the energy sector. In terms of regulations, the first quota law marks the first cornerstone of the new NCRE market that started to be developed in the country, which effect was further reinforced by the second quota law passed a couple of years after. With respect to organizations, there were multiple institutions that were created at the time as part of the general restructuration of the energy sector, with particular institutions like the CER that aimed specifically at advancing renewables' deployment.

Institutional change triggered the formation of a market of NCRE technologies in Chile. The first quota law was proposed by the government explicitly with the objective of starting a market in the country. Along with that, the government implemented multiple policies for actually realizing renewable energy policy objectives. Among them are the performance of studies on Chile's renewable energy potential, developed jointly with the GIZ. The government also did significant efforts for attracting international investors, including the efforts for developing educational material that facilitated information to such investors. Small pre-investment loans for feasibility studies were offered with support from the KfW. There government also focused on educating the national financial sector with respects to this new technology, heavily lobbying for improving access to financing on part of national banks.

Efforts made by the government were fruitful and multiple new entrants joined the NCRE sector in Chile in recent years. Most of them international investors coming from Europe that had experience with renewable energy technologies and were looking for new business opportunities. They found Chile as an attractive market thanks to the country's good business reputation, the lack of protectionist policies and the multiple Free-Trade Agreements (FTAs) that Chile has, and though they were hesitant at the beginning as the country was not offering subsidies, the high energy prices combined with the drop in technology prices ended up convincing them. This is how the multiple new investors joined the market in recent years. ACERA today has 120 members mostly including generation companies, but also enterprises that provide services to the sector. The number is striking compared to the 3 generation companies that dominated (and still do) the sector. Along with ACERA, multiple other industry associations of specific technologies in the sector emerged. Together, they have been able to boost the political power of the NCRE sector and had been able to lobby before, but also to work jointly with the government for further enabling and advancing the development of the sector, as it was the case with the public tender regulation law modification and the development of the transmission law.

An additional element that has enabled the development of the NCRE sector in Chile has been the existence of an advocacy coalition. Though the coalition has never existed formally, multiple political forces have joined forces for advancing renewables' deployment in the country, including industry associations, environmental NGOs and other civil society organizations. As it was studied in Chapter 3, the power of this advocacy coalition has been further boosted by the massive opposition to conventional energy technologies that emerged in the country during the last decade. The government was a key member of the coalition when it was trying to get the first quota law approved. Indeed, as it was explained in Chapter 3, the massive support that the coalition was able to mobilize was absolutely necessary to battle against incumbent generation companies for opening a space for renewables to develop. Later on, successive governments have not taken an explicit position in favor of the NCRE sector, but sustainability and renewables have been included as a fundamental pillar of national energy policy strategies, and the government has also welcomed and implemented suggestions for regulatory changes that further enable the sector's development.

Importantly, TIS theories highlight the need for a new technology to gain legitimacy, which in the Chilean case was likely achieved through the support of new entrants (industry associations in particular), environmental NGOs, and other civil society organizations, as well as by the Chilean government (e.g. in trying to make policy processes more participative). As mentioned previously, renewables' social acceptance was further boosted by the wide rejection from local communities and the civil society in general to conventional energy technologies.

Following Smith and Raven's (2012) argument, we might say that these four explained features (plus the legitimation element) of the transition supplied nurturing to the new market of NCRE that was emerging. They argue, though, that it in order for a niche to emerge the protected space also needs to offer shielding and provide empowerment. Shielding and empowerment are features that have more to do with the relationship between the niche and its environment, as opposed to nurturing that has more to do with the internal development of the niche. I argue that the NCRE technological niche in Chile had in fact a shield that was provided by both the quota laws and social opposition to conventional generation technologies. The quota laws —the first quota law in particular, that was proposed and pushed by the government—, reserved a space in the market for renewables. To that we can add the opposition that communities raised against conventional energy technologies that created barriers for them to enter the market and that left a demand portion unsatisfied that renewables were able to claim.

The feature of empowerment is also present in the transition. I think that both the recent regulatory change in public tender regulations, that has already showed positive results, as well as the new transmission law that was recently approved contribute, to that end, by making NCRE technologies able to compete in the market with conventional ones. In addition to that, the *Energy 2050* policy also represent an important empowerment step because, even though only goals have been set and there is still a lack of a formal roadmap, the proposed objectives have set positive expectations for the future development of the sector. Even social organizations arguably contributed to niche empowerment, as their opposition prevented conventional energy projects to develop contributing to keep energy prices high, which in turn indirectly helped to make NCRE technologies more competitive. Notably, I argue that in the case of Chile this empowerment phase coincides (using TIS jargon) with the growth phase of the transition.

I argue that the policies, regulations and institutions that the government implemented have contributed significantly to the task of setting up a protected space for the formation of a market for renewables, where the first experiences of adoption of new NCRE technologies were developed, which served as a pilot example for developers. Thus, through the creation of a protected space for renewables development, the Chilean government has been a key enabler for the introduction and diffusion of the new renewable energy technologies to Chile. This is not to argue that the government did everything perfectly nor that it could have done much more, rather it is just to recognized that what was done —though moderate, as many interviewees point out, especially when contrasting the Chilean transition with European experiences—, contributed in a significant way to develop a market for renewables in the country.

When analyzing the transition process it is possible to recognize the different elements that TIS and niche transition theories have suggested as key for the emergence of a new technology's market, even when the Chilean government has not followed a sustainability transitions management approach. Such theories though, even when they assume that governments and institutions are to play a fundamental role in a transition, do not assign them explicit tasks to play, leaving room for the implementation of different approaches. The analysis of the Chilean transition presented above explored and identified the specific functions that the government has fulfilled for enabling the emergence of a new technological NCRE niche/system in the context of a developing country. The lack of development of new technologies as well as of subsidies, and the need for developing institutional capacity are some of the features that characterize the context of emerging nations.

4.4.5. Discussion: a call for energy policy and planning

One particular overall lecture that I draw from the case study is that the Chilean story illustrates the need for policy and planning in the electricity sector, if the aim is to steer its development in a certain direction, in particular towards a transition to renewables. In the case of Chile, this need became apparent when the country was hit by several energy crises, which highlighted the need for a backup strategy. Before that, Chile used to rely completely on market forces with respect to electricity, although after the crises there was a wide acknowledgment around the need for designing a long-term energy policy strategy that would allow to be prepared for critical situations, as well as to guide the development of the sector towards a desired outcome. A process of policy design started then, and a wave of regulations was triggered along the way for the implementation of the new visions for the electricity sector that emerged. Among the strategies that the country chose for dealing with energy problems (mostly caused by its reliance on imported fossil fuels) was the decision of fostering renewables' deployment. Taking a step back now, more than a decade afterwards, it is possible to observe that in the end Chile has implemented a series of policy design and planning measures, which include the development of a national long-term energy policy, the implementation of several regulations (e.g. quota law and transmission planning measures), and the creation of several institutions. Though most of these actions were motivated by overall objectives for the sector, renewables' deployment was part of all proposed strategies from the beginning and acquired a much more central role across the years. Indeed, the case of Chile and the experiences of other countries as well seem to suggest that the need for steering the electricity sector towards renewable electricity generation entails the implementation of policy and planning measures in countries' energy strategies making apparent the unsuitability of complete liberalization.

This need for policy and planning in the electricity sector is justified on social, environmental and economic grounds. I argue that along with the rest of relevant conditions described in Chapter 2, the role that the Chilean government played in the transition contributed in a great manner to the advancement of the use of NCRE in the electricity sector in Chile. The different implemented policies have been crucial for the (relatively) rapid development of a NCRE market in the country, which has become the leading economic investment sector in recent years. This not only has contributed to the diversification and greening of the electricity mix, but also to the diversification of actors in the sector by increasing competition and lowering energy prices. All in all, the development of the renewables' sector has opened up new possibilities for Chile, though certainly much more can be done, especially in terms of supporting local technological development. The government is now trying to push the development of a solar energy industry with the objective of making of the solar energy sector a key sector for the country's economic development. However, it may be advisable for the country to instead pursue a richer market niche. I will come back to this issue in Chapter 6.

4.4.6. Looking towards the future

Interestingly, the country is now starting to push technological development in the solar energy sector, but the approach is following more of a classic implementation of a development strategy that aims at R&D investment, rather than a deliberate approach like the ones that transition management strategies propose. The Chilean government is for now focused on encouraging the adaptation of solar energy technologies with the hope of starting a solar industry in Chile, as they think Chile needs especially designed technology given the particular conditions of the Atacama Desert, and at the same time counts with comparative advantages thanks to it that might enable Chile to become a great energy exporter in the future. Some experts (especially foreigners) have criticized the strategy though, thinking that Chile should instead pursue a different niche; one that offers both comparative advantages and less competition, such as marine energy generation. Chilean experts have pointed out, though, that Chile does not have a critical mass of experts nor with the resources (or the general population's support) to start pushing the development of a new emerging technology, so the idea of exploiting comparative advantages in the solar energy sector seems a preferable option.

The strategy that the Chilean government is attempting to follow seems to go in the same direction of import substitution development ideas embraced by Latin-American countries in the 60s and 70s. These ideas appeared in the 50s and originated with the creation of the UN Economic Commission for Latin America and the Caribbean ECLAC, based in Chile (Cypher and Dietz, 2008). Economists of this tradition (also called structuralism) argued that underdevelopment had to do with the structural characteristic of an economy. The structuralist tradition describes the development process as a structural change by which the reallocation of labor, mainly from the agricultural sector to the industrial sector, is considered the key source for economic growth, since growth based on natural resources extraction has been historically inferior to the one based on manufacturing and modern services (Todaro and Smith, 2010). Structuralists at the time argued that the way for a developing country to achieve high growth rates was to develop domestic manufacturing industries through a process known as import substitution (set of import substitution policies intended to promote industrialization by protecting domestic producers from the competition of imports). Import substitution industrialization policies work by having the state lead economic development through nationalization, subsidization of vital industries (including agriculture, power generation, etc.), increased taxation, and highly protectionist trade policies. The import substitution school of thought was highly influential in the developing world and import substitution policies were implemented in Latin America, Africa, Eastern Europe and Asia in the 1960s and 1970s. However, results were disappointing and the model was challenged by the emergence of stagflation in the 70s, the Latin America debt crisis and the collapse of the socialist planning system in the 80s. As government-led strategies based on the structuralist state interventions failed in many countries, the market-led growth model appeared to triumph and to influence development thinking. Most mainstream economics explained at the time that government intervention was bound to fail because of inevitable distortion of the allocation of resources, supply and prices, and the absence of a viable incentive system (Lin, 2012).

In contrast to that experience is the model that emerged inspired in the experience of newly industrialized economies, such as Japan and the Four Asian Tigers (Korea, Singapore, Taiwan, Hong Kong), who adopted export-oriented strategies, instead of an import-substitution strategy. Starting from a low agrarian foundation, by the 21st century, all four had developed into advanced and high-income economies, specializing in areas of competitive advantage. The strategy followed by such countries combines ideas from both neoclassical economics and structural economics. It recognizes the importance of the market as the fundamental mechanism for resource allocation, but claims that in successful cases of development, the state has also played an active role in the development and transition process, as the Keynesian theories and structuralists envisioned (Lin, 2012). A World Bank report credited neoliberal policies with the responsibility for the boom, including maintenance of export-led regimes, low taxes, and minimal welfare states, and institutional analysis also revealed that some state intervention was involved. In addition, other author have pointed out that industrial policy had a great influence, such as state-imposed below-market interest rates for loans to specific exporting industries. Other important aspects include major government investments in education, (relatively) authoritarian political systems during the early years of development, high levels of US bond holdings, and high public and private saving rates.

The experience of the Asian Tigers might represent an alternative to import substitution ideas of development for Chile, suggesting the option of adopting an export-oriented strategy based on niches that offer comparative advantages. One option is focusing on the solar generation sector, but there is also the alternative of choosing other instances of the long value chain that energy services comprise, for example, related to developing specialized, exportable skills in designing system operating software for power networks with high rates of renewables penetration, or in transmission system modeling or (in the future) in energy storage management services.

One need that the discussion above suggests is the necessity of adapting existent transition management theories to the reality of developing countries. For example, as the Chilean example shows, it is likely that developing economies adopt first technologies that have been developed and tested in developed nations, and then they might be able to transition towards a technology development approach or to the conquest of a specific service-related niche. In that sense, it would be helpful to provide management theories that at first suggest how to adopt and diffuse new technologies, and provide guidelines for later on transitioning towards proper technology innovation models.

4.5. Conclusions: insights from the Chilean case for managing transitions

The Chilean case study highlights the role played by the government in the transition to renewables that the country has started to experience. Evidence shows that indeed the Chilean government has played an important role in opening a new market for NCRE generation technologies by creating an energy policy strategy, implementing market regulations and developing the necessary institutional capacity for materializing both policies and regulations. Moreover, the functions that the government has performed have targeted key aspects for transitions' development identified by sustainability transition management approaches, thus being a key enabler for the transition journey that the country has started to navigate. This does not deny that the government could have played a much more preponderant role, but it is just to recognize that implemented policies contributed in a significant way to develop a market for renewables in the country.

Beyond the specific roles that the Chilean government has played in the transition, I think the overall case represents a call for policy and planning in the electricity sector, in light of the need for steering it towards desirable societal directions, in particular towards a sustainability transition to renewable energy. The Chilean case is consistent with the experience of other economies in this respect, showing that complete liberalization does not offer a complacent answer to the sustainability challenges of our time, and then there is a need for incorporating a certain degree of policy regulation and planning into energy sectoral policy, particularly for addressing price barriers and transmission needs. This represents then a call for a balance that allows taking advantage of the benefits that electricity liberalization yields while complementing its shortcomings with appropriate policies. This might appear as evident for the developed world, especially for European nations that are used to significant state participation in economic steering, but it is something not taken for granted in developing economies, especially for Chile itself, which might find the energy sector's case informative for drawing lessons for other policy domains that might require to be steered towards more socially desirable directions/outcomes.

I expect the Chilean example might inspire other developing countries to embark in an energy transition, providing a good starting point on the role that governments are to play in that process. I think the Chilean story is particularly adequate as it depicts a case that unfolded in an emerging economy's context, characterized by a lack of new technologies' development, no subsides and the need for putting special effort in further developing existent institutional capacity. Indeed, given the urgency for unleashing a global-scale transition, especially in the energy sector, the Chilean transition case represents a call for transition theorists to broaden and adjusting their approaches for targeting transitions occurring in developing countries' realities. This might imply recommending strategies for the adoption and diffusion of new technologies (without comprising technological development at first), and suggestions for perhaps later on transitioning towards fostering local technological innovation.

Overall, it is true that results of the transition are still moderate, but progress has been substantial and prospects towards incoming years are very positive. There are multiple ways in which the government could have done its job better, but I argue that even when efforts could have been more, as many interviewees pointed out, what has been done so far has meant a great deal for the electricity shift towards renewables that the country is experiencing. Despite all the progress, there are multiple future challenges for the transitions' further development, including issues were the government is to play a protagonist role, such as the need for developing a market for ancillary services, modifying the marginal cost system, dealing appropriately with social conflicts, and fostering technological development in the sector. In Chapter 6 I will identify the most salient challenges that the transition faces for moving forward and offer some policy recommendations for dealing with them.

In Chapter 5 I will further explore the processes involved in the Chilean transition for trying to suggest how the dynamics of transitions to sustainability in developing countries' contexts might be different from those of transitions taking place in developed countries, which so far have been the focus of most available research studies.

CHAPTER 5. UNDERSTANDING THE CHILEAN ENERGY TRANSITION DYNAMICS

5.1. Introduction

This chapter resumes the analysis around the general research question that guides this dissertation: *Why has a transition process towards the use of renewable energy unfolded in Chile during the last decade? What does the empirical evidence from the Chilean case tell about how and why transition processes come about?* This implies zooming back out from the analyses presented in the recent chapters for examining the overall dynamics of the Chilean transition.

All findings and lessons learned from previous chapters inform the discussion developed in what follows. Chapter 2 presented a survey of relevant events for the transition, identifying the motivations that persuaded actors to follow determined action pathways. Chapter 3 discussed the incidence of politics and power struggles in the Chilean transition, in particular, the role that policy entrepreneurs have had in triggering and pushing forward socio-technical change. And then, Chapter 4 analyzed the role that the Chilean government has played in enabling the transition to take place. The present chapter combines all findings for elaborating an overall analysis of the dynamics of the Chilean transition.

For developing the analysis I mainly rely on theories from the sustainability transitions field. I characterize the Chilean transition in terms of the Multi-Level Perspective (MLP) approach, which implies re-telling the story assembled in Chapter 2, now from a different perspective in order to be able to explore how the transition unfolded from an overall viewpoint. Then, adopting a closer focus on actors, institutions and technology inter-relations, I analyze the general pathways that the transition have followed over the years. That analysis allows me to asses the theoretical fit of available transition theories against the Chilean case. Then, using insights obtained from the study of the Chilean transition I intend to draw some theoretical contributions on how transitions in developing countries may come about, and how they might be similar or different from those that have taken place in developed economies.

The chapter is structured as follows. The following section presents and discuss the literature on transitions theories that informs the discussion for understanding general transition dynamics. After that, I recapitulate what was discussed in previous chapters, including the policy paradigm change that the Chilean energy sector has experienced discussed in Chapter 2, and the analysis of the politics and policies of the Chilean transition explored in Chapters 3 and 4 respectively. In the next section, I analyze the dynamics of the Chilean transition and afterwards I discuss theoretical contributions from the perspective of Chile's case study. I end the chapter summarizing the discussion and lessons learned.

5.2. Literature review and discussion

5.2.1. Multi-level perspective

Transitions literature offer different approaches for understanding and managing technological transitions. There are two of them in particular that are mostly widely used to explain how transitions come about: Technological Innovation Systems (TIS) and the Multi-Level Perspective (MLP). TIS focuses on the study of the development, diffusion and use of a *particular* technology (Bergek et al., 2008). Broadening the traditional market failure approach, the TIS literature advocates for the use of a systems approach that is more intentionally driven and also tackles aspects such as institutional change and knowledge development. This approach, however, does not address structural change, that is, how emerging technologies struggle against existing systems. As much as the Chilean case was not very much intentionally driven at the beginning and in fact firstly adopted a systems failure approach that did not involve a strong push for renewables' deployment, targeting renewable energy technologies in general instead of focusing on a particular one and involved great structural change and conflict, the TIS approach does not seem an appropriate framework for understanding Chile's transition.

The MLP is an explanatory theory for understanding sustainability transitions, i.e. how socio-technical transitions come about. The MLP defines transitions as "regime shifts" that result as an outcome of the interacting processes between three analytical levels: niches, socio-technical regimes and socio-technical landscapes (Geels, 2002).

- *Socio-technical regime:* The concept of regimes emerges as an expansion of Dosi's idea of technology paradigm, analogous to Kuhn's concept of scientific paradigm. A socio-technical regime "refers to the semi-coherent set of rules that orient and coordinate the activities of the social groups that reproduce the various elements of socio-technical systems" (Geels, 2011). Examples of regime rules are: cognitive routines and shared beliefs, capabilities and competences, lifestyles and user practices, and favorable institutional arrangements and regulations. Innovation occurs incrementally, as a process of small adjustment accumulating into stable trajectories, since existing regimes are characterized by lock-in and path dependence (which refer to the idea that they are difficult to dislodge) (Unruh, 2000).
- *Niches:* Niches are 'protected spaces' for nurturing radical innovations that deviate from existing regimes, and whose performance may not be competitive against the selection environment prevailing in the regime —radical innovations, as opposed to incremental innovations, are innovations that transform some of the core rules of the existing regime (van de Poel, 2003) —. Examples of niches are R&D laboratories, subsidized demonstration projects, or small market niches where users have special demands and are willing to support emerging innovations (Geels, 2011). Niche-actors (such as entrepreneurs, start-ups, spinoffs) hope that their promising novelties are eventually used in the regime, or scale-up and even replace the existing regime.
- *Socio-technical landscape:* corresponds to the wider context, which influences niche and regime dynamics (Rip and Kemp, 1998). It includes the technical and material backdrop that sustains society, but also demographical trends, political ideologies, societal values, and macro-economic patterns. The landscape refers to an external context that actors at niche and regime levels cannot influence in the short run, because it usually changes slowly.

Figure 1 provides an ideal representation of how the three levels interact dynamically, and how transitions come about as the outcome of the interaction processes at different levels. The general pattern is: (a) niche-innovations build up internal momentum, (b) changes at the landscape level create pressure on the regime, and (c) destabilization of the regime creates windows of opportunity for niche-innovations to break-through, forcing the adjustment of the socio-technical regime.

At the same time, the MLP is a meso-level theory that conceptualizes overall dynamic patterns of socio-technical transitions. While it has a systemic approach, it focuses on certain changes at certain economic sectors rather than on entire economies' dynamics. Unlike other theories of technological innovation, such as disruptive innovation (Christensen, 1997) and technological discontinuity (Anderson and Tushman, 1990) literatures, that look at interactions between new entrants and incumbents but tend to focus on technology and market dimensions and have a technology-push character, the MLP has more of a broad approach and allows for different transition patterns. Like the long-wave theory on techno-economic paradigm shifts (TEP) (Freeman and Perez, 1988), the MLP also considers change as multi-dimensional and addresses structural change, and emphasize the dynamics and interdependencies between interacting sub-systems, namely science, technology, economy, politics and culture (Freeman and Louçă, 2001). But TEP and the MLP have different scopes though; the TEP focuses on the analysis of entire economies, while the MLP focusing on concrete systems (e.g. energy or transport) and pays special attention to the interaction between various groups, theirs strategies, resources, beliefs and interactions.

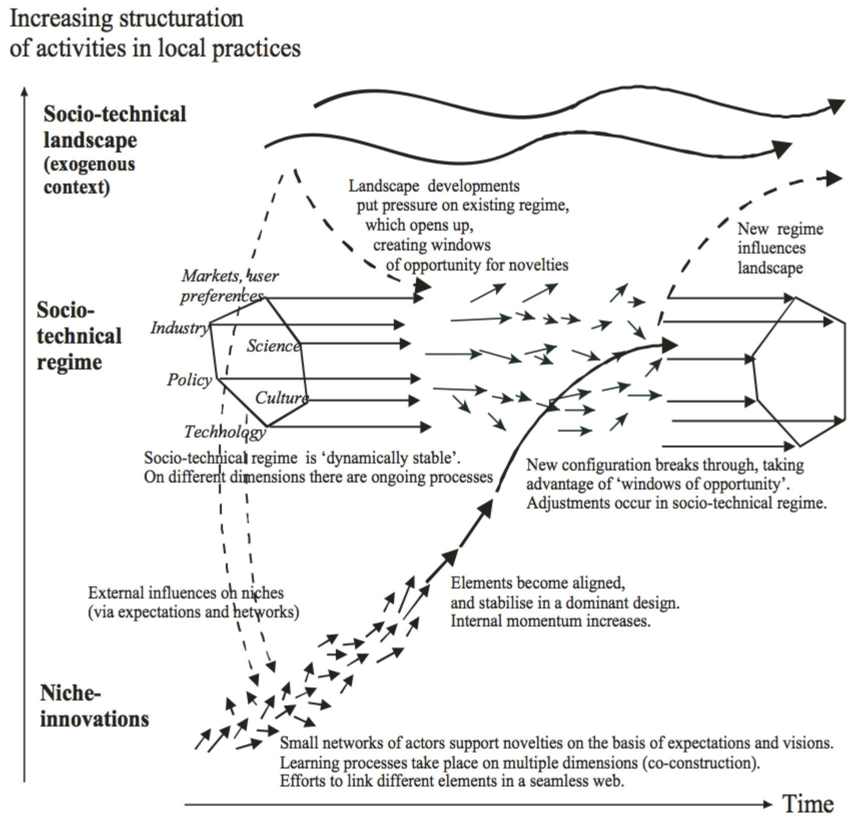


Figure 5.1. Multi-level perspective on transitions. Source: Geels (2011), adapted from Geels (2002).

Critiques

According to Smith et al. (2010), "the allure of the MLP is that it provides a relatively straightforward way of ordering and simplifying the analysis of complex, large-scale structural transformations in production and consumption demanded by the normative goal of sustainable development". Nonetheless, even though the MLP provides a useful language for organizing the necessary considerations for explaining transitions, there is a tension between appreciating the bigger picture whilst maintaining a level of abstraction that is still meaningful. As warned by Sayer (1992), the MLP should help people simplify and intervene reflexively, but must not become counter-productively simplistic in its abstraction.

Some critiques of the MLP approach relate to: the need to further define the role of agency in the model and to improve the understanding of the role of power and politics (Smith et al., 2005), the necessity of developing a methodology for performing systematic research using the approach (Genus and Coles, 2008), and the need to complement the analysis of supply with the study of demand side dynamics to analyze how daily practices affect the dynamics and outcomes of systems (Shove and Walker, 2010).

For all its characteristics, the MLP seems to be the most suitable theoretical framework for characterizing and understanding the dynamics of the Chilean transition.

5.2.2. Niches as protected spaces

Smith and Raven (2012) have further advanced the discussion on the role of niches —which they describe as "protected spaces" for path-breaking innovations—, arguing that they exhibit three functional properties: shielding, nurturing and empowerment. Shielding involves processes that hold at bay certain selection pressures from mainstream selection environments (e.g. industry structures, technologies and infrastructures, knowledge base, markets and dominant user practices, public policies and political power, cultural significance). Nurturing involves processes that support the development of path-breaking innovation. Such processes can be *passive* protected spaces, that is, generic spaces that pre-exist deliberate mobilization by advocates of specific innovation, but who exploit the shielding opportunities they provide, or they can be *active* protected spaces, defined as those spaces that are the result of deliberate and strategic creation by advocates of specific path-breaking innovations to shield regime selection pressures. Empowering involves processes that make niche innovations competitive within either unchanged selection environments (fit-and-conform pattern), or processes that change mainstream selection environments favorable to the path-breaking innovation (stretch-and-transform pattern). According to Smith and Raven (2012) "relationships between shielding, nurturing and empowerment can be understood as an iterative process: initial, passive protection enables early nurturing of the innovation, whose promise (if successful) empowers niche advocates to obtain more active protective measures that assist in further nurturing, greater empowering, and eventually the institutionalization of the innovation within a transformed selection environment".

Smith and Raven (2012) have noted that the TIS approach provides a detailed framework for understanding nurturing of innovations, with the actual success of innovations being mainly regarded as a consequence of the performance of the innovation system itself. Markard and Truffer (2008) critique the TIS approach, however, for being inward looking and not paying much attention to the system's environment. Thus, Smith and Raven (2012) argue that the TIS approach underplays the shielding of emerging innovation systems against mainstream selection pressures, and then is only able to study the internal consequences of dynamics in the wider selection environment upon an emerging system. In that sense, the TIS approach does not emphasize the interplay between the wider selection environment of an emerging system and internal system dynamics as an endogenous explanation in the emergence of that system. This implies that the TIS analysis will find it difficult to explain mass-market diffusion of path-breaking innovations, because that would inevitably involve many interactions between an emerging system and its environment.

5.2.3. Transition pathways

Early propositions of the MLP emphasized the importance of alignments between developments at the three multiple levels described above (niche, regime and landscape), though authors have further developed it suggesting that different kinds of alignments may lead to different transition pathways. Geels and Schot (2010) explain that transitions can be analyzed with lenses of different granularity. The MLP approach typically is a global model that maps the entire transition process. As an overall model, the MLP tends to give less attention to actors, yet it does allow one to zoom in to explore how actors interact. Indeed, the linkages between processes at different levels in the MLP are made by actors in their cognitions and activities, and then the dynamics are not mechanical, but socially constructed (Geels and Schot, 2007). The MLP model is then useful for offering aggregate explanations in terms of alignments of trajectories within and between niche, regime and landscape levels, though it is also possible to look further into those trajectories in the MLP which are enacted and vary in terms of who the dominant actors are and how they shape the reproduction or change of rules and institutions.

Looking for explanations of how transition trajectories are enacted, authors have proposed typologies that attempt to characterize the different pathways that transitions may incur. Geels and Schot (2007) proposed a typology based on combinations between two dimensions —the timing and nature of multi-level interactions—, which led them to distinguish four transition pathways: transformation, reconfiguration, technological substitution, and de-alignment and re-alignment. Building on the typology elaborated by Geels and Schot (2007), Geels et al. (2016) propose a reformulation of the suggested transition pathways in terms of actors, technologies and institutions. The reformulated typology argues that transition pathways vary according to the interactions between those actors, rules and institutions and technologies, which result in different kinds of transition trajectories.

- *Substitution pathway:* This pathway is characterized by radical technological innovation(s) substituting existing technology. In terms of actors, the substitution pathway comprises the entrance of new firms that struggle against incumbent firms, which leads to overthrow. It is possible that these new entrants correspond to activists, social movements and citizens with normative motivations that develop and deploy radical sustainability innovations. New entry may also come from incumbents that diversify from other sectors. With regard to institutions, the substitution pathway may follow two patterns. One option is what Smith and Raven (2012) call a *fit-and-conform* pattern, which occurs when only limited institutional change occurs implying that niche-innovations are developed to fit existing rules and institutions and need to compete in an existing selection environment. The other pattern is what Smith and Raven (2012) call *stretch-and-transform* pattern, and involves the adjustment of rules and institutions to suit the niche-innovation, which is likely to involve power struggles, socio-political mobilization and counter-mobilization.
- *Transformation pathway:* The transformation pathway consists of gradual reorientation of the existing regime through adjustments by incumbent actors in the context of landscape pressure,

societal debates and tightening institutions. In this pathway, incumbents may reorient incrementally by adjusting search routines and procedures; or they might reorient substantially, to radically new technologies or, even more deeply, to new beliefs, mission, and business model. In terms of technologies, this pathway may imply incremental improvement in existing technologies (leading to major performance enhancement over long time period), incorporation of symbiotic niche-innovations and *add-ons*, or reorientation towards new technologies: (a) partial reorientation, with incumbents developing both old and new technologies; (b) full reorientation, leading to technical substitution. With regard to institutions, they suggest that different depths of reorientation are associated with different degrees of institutional change. Incremental technical change and *add-ons* are likely to involve limited institutional change, while partial reorientation and full reorientation are likely to entail higher degrees of institutional change, which might enhance pressure on incumbents leading to struggles between policymakers and industry actors.

- *Reconfiguration pathway:* In this pathway, niche-innovations and the existing regime combine to transform the system's architecture. In terms of actors, this pathway can involve new alliances between incumbents and new entrants rather than overthrow. In terms of technologies, niche-innovations may initially be incorporated as *add-on* to existing technologies. Subsequently, however, these new technologies may create unintended problems or opportunities that invite further changes, thus triggering "innovation cascades" and knock-on effects that substantially reconfigure system components and their relations. Reconfiguration processes are likely to start with limited institutional change, followed by more substantial change as actors encounter new problems, change their goals and see new opportunities. Institutional change may involve struggles between new entrants and incumbents to suit their interests.
- *De-alignment and re-alignment pathway:* In this pathway the existing regime is disrupted by external shocks (e.g. wars, population displacements, economic collapse), which is followed by the rise of multiple niche-innovations and constituencies, one of which gradually becomes dominant. The decline of old technologies creates space for several innovations that compete with

one another. Institutions are disrupted by shocks and replaced, possibly after prolonged uncertainty.

Table 5.1 summarizes the aforementioned transition pathways along the three categories of actors, technologies, institutions.

Table 5.1. Typology of transition pathways. Source: Geels et. al (2016).

Transition pathway	Actors	Technologies	Rules and institutions
(1) Substitution	New firms struggle against incumbent firms, leading to overthrow	Radical innovation(s) substituting existing technology	Limited institutional change, implying that niche-innovation needs to compete in existing selection environment ('fit-and-conform') ('Incremental adjustment', 'Layering')
	Different kinds of 'new entrants' (e.g. citizens, communities, social movement actors, incumbents from different sectors) replace incumbents		Creation of new rules and institutions to suit the niche-innovation ('stretch-and-transform') ('Disruption', 'Displacement')
(2) Transformation	Incumbents reorient incrementally by adjusting search routines and procedures	Incremental improvement in existing technologies (leading to major performance enhancement over long time period).	Limited institutional change ('Layering')
		Incorporation of symbiotic niche-innovations and add-ons (competence-adding, creative accumulation)	
	Incumbents reorient substantially, to radically new technology or, even more deeply, to new beliefs, mission, and business model	Reorientation towards new technologies: (a) partial reorientation (diversification) with incumbents developing both old and new technologies (b) full reorientation, leading to technical substitution	Substantial change in institutions ('Conversion', 'Displacement')
(3) Reconfiguration	New alliances between incumbents and new entrants	From initial add-ons to new combinations between new and existing technologies; knock-on effects and innovation cascades that change system architecture.	From limited institutional change ('Layering') to more substantial change, including operational principles ('Drift', 'Conversion')
(4) De-alignment and re-alignment	Incumbents collapse because of landscape pressure, creating opportunities for new entrants	Decline of old technologies creates space for several innovations which compete with one another	Institutions are disrupted by shocks and replaced, possibly after prolonged uncertainty ('Disruption')

Shifts between pathways are likely to occur as transitions unfold depending more on endogenous enactment, than on external landscape change, as Geels and Schot (2007) noted. Transitions are continuously enacted by and contested between a variety of actors (Geels et al., 2016), and then they are continuously shaped based on actor struggles over technology deployment and institutions (Smith and Raven, 2012). Geels et al. (2016) emphasize that transitions are likely to be non-linear, that is, to unfold unevenly through sudden advances and setbacks, depending on changing coalitions and contexts, unintended consequences and learning processes. They suggest that nonlinearities may take the form of shifts between transition pathways as struggles between actors affect technology deployment and institutions. Nonlinearities may also arise from active delay and resistance strategies from incumbents, including the creation of counter-movements.

5.2.4. Developing countries' transitions

The context of developing countries is even more hostile for transitions to take place than the one of developed nations. The Sustainable Development Goals (SDGs) recently launched in 2015 by the United Nations (especially) speak about the needs of the developing world. Under the current panorama, several rapidly industrializing economies (many of which are resource based) are looking to the Asian industrializers aiming to pursue accelerated development, but now in a climate and resource constrained world. Researchers have argued that late developing countries are not condemned to following the same high-resource-intensity and high-pollution trajectories of economic transformation of previous cases of industrializations (Moomaw and Tullis, 1994), and that alternative, more sustainable pathways are possible (Berkhout et. al, 2009). Furthermore, after the publication of the UN SDGs, the Paris Agreement and the National Determined Contributions (NDCs) —which altogether aim to establish a worldwide paradigm shift towards sustainable development,— the global community is demanding that the pursuit of development is now done in a sustainable way. In line with these needs, Swilling et al. (2015) have claimed for the need of a just transition; a structural transformation that involves the achievement of developmental welfarism and a sustainability transition.

But besides the hurdles that developed countries face, developing countries have to deal with additional constraints that prevent them from pursuing sustainability, such as much more scarce resources, many urgent (competing) needs that require attention and financing, and lack of adequate institutional capacity, among others. In addition to that, they do have either clear de-carbonization or clean energy transition plans, nor a pipeline of prospective projects that leads them in that direction. In practice, it is much more difficult for developing countries to make the decision of allocating additional resources to make projects more sustainable. In that sense, the existence of a business case for supporting sustainable initiatives becomes primary, as it would certainly boost the development of more sustainable projects. One additional adverse fact is that developing countries only make little investment on research and development. Sagar and Majumdar (2014) note that "while sustainability challenges are most stark in developing countries, these countries also generally have the least technical and institutional capabilities to leverage technology to meet these challenges".

Though few, some transitions happening in developing countries have been studied shedding some light on how their dynamics might deviate from those happening in developed countries, given their different contexts. Solomon and Krishna (2011) studied the energy transition from an oil-based transportation system to one based on sugarcane-ethanol in Brazil that took place during the last three decades. The country has utilized sugarcane-based ethanol as a transportation fuel since 1925. As petroleum-based fuel became inexpensive, especially after World War II, bio-ethanol's potential was largely ignored until the oil crisis of the 1970s (Leite, 2009; Balat and Balat, 2009). When the OPEC oil shock occurred, Brazil was importing 80% of its petroleum. At the same time, a near collapse in sugar prices hit the country's economy. As a response to the impending financial crisis caused by these two events, Brazil initiated an aggressive pursuit of domestic ethanol production. The decision was based on political and economic factors, with multiple government objectives coming into play to reduce oil imports, support local sugar producers, and strengthen domestic car manufacturing. Today, Brazil is the world's largest exporter of ethanol and, a world leader in ethanol technology, production, and consumption (Hira and de Oliveira, 2009). Brazilian experience with a policy-driven energy transition over three decades was successful on economic, environmental and societal fronts, which yielded the most important and least cost biomass energy program in the world. The program started with 0.9 billion liters of ethanol production in 1975, and grew by a factor of 30 to exceed 27 billion liters by 2009 (Gee and McMeekin, 2011).

The success of Brazil's program was due to three main factors: multiple government objectives were met by supporting a major ethanol program; widespread stakeholder support coalesced for the program (despite some initial opposition); and the government's emphasis on technology innovation

(Lehtonen, 2007; Gee and McMeekin, 2011). The Brazilian government provided a strong support and subsidies for the sugarcane industry, including subsidies to consumers and to ethanol industries for investment and consumers, as well as price control of ethanol with respect to gasoline. Although the program was initiated during a military regime, it was eventually well supported by key stakeholders from civil society, the agricultural sector, and automobile manufacturers (Goldemberg, 2007). Brazilians saw the program as a movement of national self-confidence, international recognition, and local pride. The Brazilian government supported research and technology development, and economies of scale allowed large decreases in ethanol production costs. Substantial investments were made in every aspect of the industry, including genetics research and improving sugarcane breeding.

In discussing transitions happening in developing countries, Berkhout et al. (2010) have pointed out that learning and technology diffusion between experiments, niches and regimes face multiple institutional barriers. Indeed, by studying transitions occurring in Asia, some scholars have argued that alternative, more sustainable development pathways are likely, but the existence of appropriate institutional conditions is needed for the alignment of regimes and landscape to allow for sustainable innovations to have transformative effects (Berkhout et al., 2010). Rehman et al. (2010) argue that (up until 2010) India’s approach to the dissemination and popularization of renewable energy technologies had had limited success due to barriers in planning, implementation, capacity building, publicity, allocation of and access to financial resources, and technology adaptation to local needs. In the same vein, Jolly et al. (2012) studied five promising solar PV ventures in India, noting that they were facing multiple constraints for effecting broader institutional change (institutional upscaling). They point out that institutional upscaling is generally beyond the scope of individual enterprises and requires concerted action from a critical mass of entrepreneurs. In all studied cases they found it difficult to be involved in institutional upscaling. Indeed, most enterprises had advised government officials and heavily lobbied for addressing renewables’ barriers (which include subsidies to fossil fuels, taxes to solar energy products, and lack of financing), but their efforts had not resulted in any major institutional changes.

In line with the above, Bai et al. (2009) based on the analysis of four case studies of sustainability experiments in Asia (in Indonesia, China, Bangladesh and the Philippines), argue that disturbances at various levels (niches, regimes, landscape) alone are not sufficient to generate system's changes. Their analysis indicates that despite the efforts made for incorporating *sustainable development* as a goal in national policies in Asian countries, and the numerous successful sustainability experiments documented at local level throughout the region, underlying trends are away from sustainability. According to them, this highlights the need for establishing linkages between local level initiatives that promote sustainability and national level policies. Indeed, they argue for the need of a robust mechanism that captures the positive momentum of the disturbance at a certain level and then reflects and links it to upper and lower levels of the system, for creating a synergy towards transformation, in order to overcome the effects of factors that obstruct the up-scaling of good practices and the down-scaling of good policy intentions. This suggests the importance of simultaneous and coordinated action to initiate a transition, and the opportunity to capitalize on the positive momentum of championing an experiment or an emergent regime change (Bai et al., 2009).

With all, the literature on transition currently focuses on European developed countries, and then it is a pending issue whether available approaches might or not fit to the case of developing countries, in terms of both theories for understanding transitions as well as frameworks for managing them. Though it is still a pending issue whether it is possible to apply concepts developed in Europe to the developing world, or there is a need for adapting them to the different realities of the South (Torrens, 2016).

<u>International influence and technology transfer</u>

An important aspect of technological transitions happening in the developing world refers to the idea that they are likely to be characterized by international influences and technology transfer processes. International trends and ideas are likely to impact developing countries' transitions in an ideological way, putting issues on the policy agenda, as it has happened with climate change, and offering a range of policy possibilities for addressing them. The study of the Costa Rican and Bolivian environmental policies developed by Steinberg (2001) unraveled the pervasive and long-standing influence that foreign environmental policy ideas exerted on contemporary conservation policymaking. His study shows that ideas of international origin were influential on policy reformers in addressing the normative, evaluative, and prescriptive questions of environmental management.

In addition to the above, and considering that transitions in developing countries are likely to comprise significant technology imports, they are consequently likely to involve important technology transfer processes. Putting it simply, technology transfer refers to the transferring process of new technology from the originator to a secondary user, especially from developed to less developed countries in an attempt to boost their economies (Oxford Dictionaries, n.d.). According to the Intergovernmental Panel on Climate Change (IPCC) technology transfer comprises a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders (IPCC, 2000). Under this broad definition, technology transfer processes might go from encompassing a flow of capital goods and equipment, to the transference of skills and know-how for operating and maintaining equipment, or to encompass a flow of knowledge and expertise for generating and managing technological change. The last case being the most impactful for enabling the creation of new technological capacity through the active independent learning, creation and innovation of the recipient (Bell, 1997; Wei, 1995; Ockwell et al., 2008). In the context of energy transitions, evidence-based literature shows that the main enabling elements for successful technology transfer are: (1) adequate institutional and economic frameworks, (2) appropriate absorptive capacity, (3) large and stable demand, and (4) supportive policies for low-carbon technologies, which help to bridge the gap between low-carbon solutions and their commercial viability (Pueyo et al., 2011). Depending on the presence of such elements is that developing countries would or not be able to take advantage from technology transferring processes as platforms for boosting their economic development.

5.3. Recapping from previous chapters

For this chapter's analysis I use insights gathered from Chapters 2, 3 and 4. This section briefly recapitulates on findings and lessons learned from each one of them.

5.3.1. The Chilean energy transition as a collection of figures and events (from Chapter 2)

Chapter 2 presented the collection of facts that form part of the Chilean electricity transition. The chapter started providing a general description of the Chilean macroeconomic context and an overview of Chile's electricity system in Section 2.2. After that, Section 2.4 offered a timeline of relevant events that took place during the transition period under study and Section 2.5 presented the transition in terms of quantitative facts and figures. Informed by previous sections, Section 2.6 described the transition process linking events in a sequential way (to the extent possible). Then, Section 2.7 offered a characterization of the policy paradigm change that the Chilean energy sector experienced during the last decade, comparing the current situation with the state of things before 2004.

5.3.2. Politics of the Chilean transition (from Chapter 3)

Chapter 3 explored the politics of the Chilean transition process, especially how political processes and power struggles developed and ended up yielded outcomes favorable to NCRE deployment. The analysis highlights the role that environmental NGOs and NCRE industry associations, acting as policy entrepreneurs played in the transition process introducing ideas and pushing and lobbying for them, and especially as builders of advocacy coalitions for enabling policy change. In the Chilean case in particular, the transition was in great part enabled by the interference of massive social movements and local communities who motivated by environmental and equity reasons raised fierce opposition against conventional energy projects, blocking their development. The chapter also underlines the fact that the social character of the Chilean transition forced the entire energy sector to start contemplating participation and legitimacy as important pillars for both energy policy-making and business development in the sector.

5.3.3. Policies of the Chilean transition (from Chapter 4)

Chapter 4 offers a detailed exploration of the policy side of the Chilean transition. The chapter assesses the role that the Chilean government has played in enabling the opening of a new market for NCRE generation by creating an energy policy strategy, implementing market regulations and developing the necessary institutional capacity for materializing both policies and regulations. Indeed, the analysis shows that the functions that the government has performed have targeted key aspects for transitions' development identified by sustainability transition management approaches. A particularly important finding of the chapter is that the Chilean transition to renewables has been part of a broader reform of the entire energy sector, which has entailed a shift from a market-based approach to energy policy towards one that recognized the need for incorporating a certain degree of policy regulation and planning in order to be able to steer the sector towards socially desirable outcomes.

5.4. Understanding the dynamics of the Chilean transition

5.4.1. Characterizing the Chilean transition from an MLP perspective

The Chilean transition to renewables can be studied through the lens of the MLP. In this section I interpret the transition using MLP language; characterizing regimes, niches and the landscape, and how they have evolved across the different stages that the transition has navigated. The recognition of such stages has been made for research purposes informed by historical events, but it does not necessarily imply that there has been a specific event that clearly defines the shift from one stage to another.

<u>Chile's general landscape</u>

Chile is a transition economy that enjoys good macroeconomic indicators and has the reputation of being stable and healthy for developing countries' standards. Since the dictatorship period in the 80s, the country is dominated by a neoliberal political regime, with strong reliance on market mechanisms and minimum government intervention in all sectors. State intervention is barely justified when the market is not functioning properly. The Chilean economy is reliant on commodities' exports. In particular, it is strongly dependent on the mining industry of copper, the mining sector being the main electricity consumer. On the other hand, Chile does not have an important manufacturing industry and there is almost no development of technology products in the country. With all, because of its stable economy and consolidated rule of law and institutions, Chile has a good reputation for attracting foreign investment. Another important landscape feature is that Chile is a very centralized country, with most policy decisions being made in the capital Santiago de Chile.

The prevailing regime by 2004

The prevailing regime in the electricity sector by 2004 was characterized by a fully liberalized electricity market with almost no regulation on part of the state. This, with the vision that leaving decisions in hands of the market would yield the best outcome for society. The privatization and liberalization process had taken place, starting in 1982 during the dictatorship, and after that the country did not implement an energy policy strategy, neither policy regulations for assuring energy security. Environmental sustainability was not a core objective of the sector either. The National Energy Commission (in Spanish *Comisión Nacional de Energía*, CNE) oversaw the sector's general operation, being at the time part of the Ministry of Mining. The Superintendence of Electricity and Fuels (in Spanish *Superintendencia de Electricidad y Combustibles*, SEC) was the institution in charge of watching over technical regulatory requirements and monitoring prices, especially those for regulated clients that were served by distribution companies.

The energy generation mix was mostly dependent on energy imports of conventional energy sources, as Chile does not have indigenous fossil fuel resources. The electricity mix was reliant on Argentinian natural gas and imported coal, and (also) from hydroelectricity generation at large scale in the central region of the country. The electricity generation market was characterized by the predominance of big generation companies, with three of them dominating the market. In the 90s, when the gas contracts with Argentina were signed and a pipeline for gas importation was built, natural gas was cheap that all the expansion of the sector was built and planned around natural gas. Up until 2003, almost all future expansion projects recommended by the National Energy Commission were combined cycle gas turbines, including projects to be ready as far ahead as 2013 (CNE, 2003).

It is important to mention here that Chile did not have a consolidated green political party or coalition as the ones that are common in Europe, neither a particularly strong group of environmental NGOs, nor with an unusually strong group of industry associations in the electricity sector.

<u>Renewables start to develop 2005-2013</u>

After 2004, Chile embarks in a process of regulatory and institutional reform in the electricity sector unleashed by the reduction of Argentinian natural gas exports to the country, which yielded the urgent need for securing energy supply caused by this crisis. This opened up an opportunity for renewables, who started to be seen as an option for addressing Chile's energy needs.

i. Regime dynamics

Actors and institutions

In 2004, Argentina announced the cut down of natural gas exports to Chile triggering a severe energy crisis. The event made apparent the need for having a national long-term energy strategy that enabled the country to ensure energy supply. This need was highlighted even more by a severe drought that started around 2007 and lasted around 7 years. Around 2005 a wave of regulations in the electricity sector started to take place. First, two transmissions laws (Short Act I and Short II) were passed that sought to improve the safety of the energy supply transmission system. In 2008, the government published a first document of guidelines for the future creation of an energy policy strategy, and after that a new national energy policy strategy was proposed in 2012, by the right-wing coalition that had assumed power in 2010. In that document, the government expressed explicit interest for fostering renewables' deployment as a relevant part of the country's national strategy. It is important to mention with respect to the policy paradigm change that Chile started navigating throughout these years that at first achieving sustainability was low in the list of national priorities, headed by energy security and economic efficiency objectives, though as global trends started to align towards sustainability goals, Chile also started to embrace sustainability as a fundamental pillar of the energy sector.

The institutions that governed the energy sector in the country also started to be modified from 2007 onwards. Before that, the energy sector in Chile depended on the Ministry of Mining. The CNE got separated from the Mining Ministry in 2007, and in 2010 the Ministry of Energy was created (the Ministry for the Environment had just been created in 2009).

Actors and technologies

The effects of the Argentinian gas crisis started to be felt in Chile around 2006. Chile was in need for a quick solution that allowed the country to satisfy its growing energy demand (for continuing to enable economic growth). In 2005 the immediate solution for Chile's electricity problem was found on diesel and derivatives, and in the long-run the cheapest alternative was thought to be coal, so Chilean companies started to build thermoelectric plants and to import coal massively. This is how the installed capacity in the years between 2005-2010 grew mainly in terms of coal-powered plants, and the country shifted from a natural gas mix to be mainly dependent on coal during those years. But the wave of coal power plants rapidly unleashed pollution scandals and important opposition from local communities. In addition to that, hydroelectric mega projects, which were also conceived as a possible solution to Chile's energy problem, faced similar opposition on environmental grounds. Rejection was massive on part of local communities and environmental NGOs who were able to mobilize substantial support from Chilean civil society. It turned out to be very difficult to build thermo-electric projects or massive dams in those years in Chile.

ii. Niche developments

Actors and institutions

Many factors contributed to the high energy prices that Chile begun to face in 2007, when the effects of the gas crisis combined with a severe drought in 2007/2008 (that lasted around 7 years) hit the country. That coupled with high international prices of oil, as well as with a period of high coal prices. Due to the lack of supply resources, generators were allowed to burn diesel when necessary to fulfill their contracts, and they ended up passing most of the difference in costs on to users. In addition, the difficulties for implementing new projects of cheaper conventional energy technologies due to social opposition added another complicated factor. Indeed, pollution scandals started to erupt massively from 2006 onwards due to emissions and industrial residuals related to coal-based electricity generation. Local communities started to oppose thermoelectric projects mostly on environmental grounds, especially in the north of the country. Along with that, strong opposition against large hydroelectric generation projects started to arise from 2005 onwards, particularly with the announcement of the *HidroAysén* mega-project, planned to be built in the Chilean Patagonia region. Communities opposed conventional projects formally on environmental grounds, but there were other underlying motivations such as equity reasons, lack of participation in the design process and fear of new technologies.

As a result of the massive public opposition that conventional energy projects unleashed, they started to face long lead-times as a result of environmental concerns and the process of getting environmental approval from the Ministry of the Environment to move forward. This massive opposition to large-mega projects many times led to legal disputes, with projects eventually left undeveloped in many emblematic cases (*Hidroaysén*, *Castilla*, *Barrancones*) due to a Supreme Court's ruling or even a governmental decision of discontinuing certain projects. The stop of several mega-projects left a portion of the projected electricity demand unsatisfied and thus offered an opportunity for the development of alternative energy technologies. Though there were also a couple of cases in which NCRE projects faced important opposition (like the *Mar Brava* case), in general they did not have to deal with great opposition on part of communities and the general public.

Though communities and the civil society in general maintained a strong opposition against conventional energy projects from 2005 onwards, they did not advocate explicitly for the use of renewable energy resources. The role of actively pushing for the deployment of NCRE technologies was assumed by other social organizations, namely environmental NGOs and NCRE industry associations (called *asociaciones gremiales* in Spanish), which had different motivations between each other but joined forces for advancing a common interest. Environmental NGOs were the ones that had firstly started pushing for the use of renewable energy sources in the country. In early 2000s they have started lobbying for the implementation of incentives for renewables' deployment, and thanks to that push the Short Act I passed in 2004 incorporated a modest incentive for NCRE development: total exemption from transmission charges for small projects below 9MW (including NCRE), and partial for NCRE projects between 9 MW and 20 MW. They continued advocating constantly for renewables' deployment and supporting communities in their protests against conventional energy projects founded on environmental reasons (even leading and organizing the opposition in many cases), they heavily lobbied in favor of the renewables' laws and published studies on Chile's renewable energy potential.

NCRE industry associations also supported actively the opening of a market for renewables motivated by a business interest. They worked hard, advocating in favor of the NCRE laws, proposing new regulations to the government, and publishing studies that backed the positive contribution of renewables to the Chilean market. Many of these associations emerged during the final years of the last decade and the beginning of the present one joining the work that existent associations were doing.

Around 2006-2007 the government started to seriously consider the option of electricity generation from renewable energy resources as a mean for diversifying the country's electricity generation mix and increasing energy security. In 2007 the government proposed a quota law for pushing forward the entrance of renewable energy technologies into the electricity generation market. The quota law was expected to overcome the barriers that renewables' deployment was facing, namely the fact that incumbent companies were not interested in the market, and that new entrants were not willing to cope with all the risk that entering a market without the guarantee of success entailed. The government decided not to offer subsidies as they considered that developed countries had already subsidized such technologies, while also Chile had other priorities as a small developing country whose emissions were comparatively marginal. The first quota law was finally passed in 2008. It was sponsored by the government, who pushed it forward along with environmental NGOs and renewable energy industry associations (mainly ACERA, see Chapter 3). The government in office at the time (left-wing coalition) sponsored it with the explicit objective of enabling the entrance of renewable energy technologies to the electricity market in Chile. The main motivations were related to energy security and economic efficiency, as it was thought that the entrance of renewables was going to diversify the generation mix and help increasing competition in the sector, which was expected to lower the skyrocketing energy prices that Chile faced at the time.

The discussion of the quota law was not exempt from opposition. The diversification of the energy generation sources was being forced by means of imposing a burden on big generators. The law faced huge opposition mainly on part of the three big generation companies that dominated the market at the time (and still do so). They were supported by conservative think-tanks and by right-wing congress people (who are generally ideologically against market interventions). The opposition stood on the grounds that renewable electricity generation was expensive, and was not affordable for a developing country like Chile, whose CO_2 emissions were less than 2% of the world's. In the end Congress massively supported the law and in spite of the opposition, and the bill was passed in 2008 with no votes against (just a couple of abstentions).

In 2013, a second law (Law Nº 20.698) that promoted the use of NCRE was passed augmenting the 10% goal of electricity generated agreed for 2024 to 20% to be reached in 2025 (the incremental percentages were consequently also modified). This law was the result of the initiative of some parliamentarians that worked along with environmental NGOs and NCRE industry associations, and the initiative again enjoyed strong congress support and was approved unanimously. Opposition from incumbent companies this time, was founded on safety and quality motives, arguing that the intermittence associated with NCRE technologies —solar and wind in particular— introduced physical complications to the electricity grid that prejudiced the stable and constant operation of the electricity system. Importantly, so far experts report not to have observed important impact on the overall quality of electricity services.

Environmental NGOs and NCRE industry associations allied for working to open a space for NCRE technologies, especially for lobbing in favor of the first and second quota laws. The two groups of social organizations also led a couple of initiatives were different institutions from the civil society sit together to talk about energy policy and renewables deployment (e.g. the CCTP and *Scenarios 2030*, see Chapter 3). Indeed, they constantly advocated in favor of renewables' development exerting pressure on the predominant regime and working vehemently for the development of the new regulations that contributed to open up the market for renewables.

Along with the creation of the Ministry of Energy in 2009, the government created the Renewable Energy Center (in Spanish *Centro de Energías Renovables*, CER) —which was part of the Chilean Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*, CORFO)—, with the aim of supporting investment in the sector. The CER offered modest amounts of funding for financing pre-investment feasibility studies, and developed studies about Chile's energy potential, as well as guides about the operation of the Chilean electricity market, all of which helped raising and diffusing information. The CER also promoted foreign direct investment in Chile's renewables sector through multiple international campaigns, worked constantly for facilitating access to financing for NCRE projects by offering support for projects before multilateral organizations for accessing loans, and helping the national private sector to understand the new technologies for dissipating the risks associated to them. It might be of interest that the pre-investment grant offered by CORFO was partly funded by the Germany's KfW Development Bank. Indeed, since the late 1990s, the Chilean government has received support from Germany through the German Society for International Cooperation (GIZ) on energy matters, which has helped in exploring and mapping out the country's renewable energy potential, has implemented programs for training workers, and has offered the government constant advice in sustainability and energy policy matters. Though not as intensively as Germany, the US has also supported Chile in advancing renewables' use. Indeed, the CER was launched with support from the US Department of Energy and the US National Renewable Energy Center (US ITA, 2013).

Actors and technologies

The first projects that started to implement NCRE technologies in the last decade —especially wind farms and solar PV power plants, but also small-scale run-of-river hydropower installations— were perceived as pilot projects and pioneer examples whose outcome greatly determined the future of the sector.

In the case of wind generation plants, the very first examples —which entered the grid around 2006, developed by incumbent companies— in general resulted not to be economically convenient, as they had been developed motivated mainly by strategic reasons or social corporate responsibility. Indeed, multiple interviewees commented that they actually had a negative influence on the development of the sector, possibly delaying the transition since their bad performances discouraged investors. After that, with improvements in technology and efficiency, and drops in technology prices, future projects started to prosper. In contrast to the first experience with wind energy projects, the first solar PV arrangements (developed by new entrants, which started to operate in 2012) were all generally successful and influenced development positively from the beginning.

The first wind and solar projects that succeeded were generally funded by multilateral organizations that were willing to bear the risks of renewables' deployment in Chile and in the Latin American region. Private and financial sector executives recognize the role that these organizations played in Chile in opening the market for renewables and in taking the risk of financing the first projects in the renewable energy sector. These were all private sector initiatives developed by international companies that had come to Chile mostly from Europe (that already had experience in renewables' development), motivated by the depression of the renewables' market in European countries and attracted by the good conditions that Chile's electricity market had to offer. Some mining companies decided to take the risk and to get contracts for purchasing energy from renewables' developers in an attempt for lowering the extremely high energy prices that conventional generators were charging them. Given the high prices, other developers decided to enter the market even without Power Purchase Agreements (PPAs), that is, selling energy to the spot market. When the first projects started to show the technical feasibility and cost-effectiveness of these new technologies and its good performance other international sources of financing, including access to loans or interest from international investment groups, became available for developers and development in the sector started to proliferate.

The case of small hydropower generation plants was a bit different. Hydropower technologies were long known in the country, though mostly for large scale applications. In that sense, there was a lot of regulation already developed that favored the development of small-scale projects in the sector. The major barrier for run-of-river power plants was not the unawareness of the technology, but the limited financing availability that was prejudiced by the skepticism regarding the profitability of small scale projects, as well as due to the fact that developers were not the traditional dominant companies but rather new unknown entrants. In that sense, the first niches corresponded to the first projects that were able to get access to financing, and then the prosperousness of such niches depended on the profitability of these pioneer enterprises. Notably, at the beginning, funding for the first run-of-river small projects also came from international development banks, international organizations and the national development agency. Another barrier of these projects was related to the obtainment of permissions that were difficult to get, not because there was not regulation for that, but rather because the institutional apparatus of the state was not used to and ready for taking care of the explosion of requests submitted for review when run-of-river projects started to proliferate.

Importantly, as the development of the renewables' sector in Chile was triggered mostly by new entrants that were not associated to big capital, the availability of financing options for making investments was crucial for the deployment of NCRE generation technologies in the country.

Financing from local banks by the end of the last decade and the beginning of the current one was almost only available (in a limited way) for small run-of-river projects, as banks have had some familiarity offering financing options to larger dams and run-of-river power plants, and they are not considered variable technologies either.

Biomass energy projects had started to appear around the early 2000s, though their development has been mostly limited to plants that generated electricity as a co-production from industrial waste from the pulp and paper industries. Indeed, according to the USDA Foreign

Agricultural Service (US ITA, 2013), Chile's forest industry has became so cost-efficient at converting its waste to electricity that it abandoned efforts to convert it to second-generation biofuels.

Renewables' development starts to expand 2014-2016

This period is characterized by the scaling up of NCRE technology niches, which developed and started bouncing into the regime. Several actors and policy changes, along with economic factors and landscape conditions, enabled this to start happening. So far, the transition has resulted in an important reshape of the dominant regime in terms of policies, regulations, institutions (in the sense of organizations) and power distribution.

i. Niche developments

Actors and technologies

There is general consensus across stakeholders in the sector on the fact that the quota law implemented in the country sent a positive signal and a market for NCRE generation started to develop quickly, even without the implementation of significant subsidies. The combination of good conditions for the development of renewables resulted in a rapid expansion of NCRE sector. The availability of high-quality renewable energy resources, high energy prices, the fact that conventional energy projects faced strong opposition from communities across the country, the existence of a stable regulatory framework, the commitments sustained by the government to continue to support renewables' deployment, promising energy demand expectations, the increasing availability of financing options, and the improvements in efficiency, as well as the continuous drop in technology costs, especially of PV panels and wind turbines, contributed to the increasing development of NCRE projects in Chile and to the boom of solar photovoltaic plants and wind farms that erupted in the country in 2014 and 2015. Wind technology prices dropped heavily before 2009, while solar PV technology prices dropped impressively after 2010, in contrast to fossil fuel technologies that have mostly maintained their prices. By the means of all the aforementioned factors it turned out rapidly to be economically convenient to develop renewable energy power plants, even without supporting of subsidies, which were not necessary as developed countries had already subsidized the development of such technologies. Indeed, though niche development processes normally take time, in Chile there was no need to give space for the development of technologies, but only for the successful implementation and operation of pilot projects that incorporated new technologies. All the described conditions contributed to reaching a so-called grid parity for solar PV plants and wind farms earlier in Chile in comparison to other countries (roughly around 2013-2014).

The boom was also enabled and fueled by the increasing availability of financing. Indeed, it was not until later (around 2013/2014) that the national financial sector started to get seriously interested in investing in these new energy technologies, after witnessing the development of many successful projects. The Chilean financial sector is very conservative and banks were not willing to take the risk that the development of new technologies entailed. When the NCRE sector recently started to emerge around 2005, banks were still used to corporate finance schemes and were not willing to take the risk of offering project finance options for non-consolidated technologies that had not proven an ability to properly work for already a couple of decades. When the NCRE sector started to develop and national banks witnessed several successful enterprises, they started to learn about how these new technologies operated and were willing to offer them financing options. At first, when they finally decided to enter the financing market for NCRE technologies, they were willing to fund projects that were going to be financed selling energy to the wholesale market at spot prices, but as more and more renewable energy projects entered, bottlenecks started to occur in the transmission system revealing its flaws. As spot prices suffered from high variability and lack of predictability, in 2016 banks were not willing to take the risk of the spot market any more and stopped funding projects that did not have PPAs. Obtaining a contract though is difficult in Chile as *free clients* are not quite familiarized with these technologies and instead are used to buy power blocks that guarantee a constant amount of power, something that renewables cannot offer. The alternative option was then to appeal to public tenders to get the desired contracts that allow developers to get funding from local banks. This is how the niche of NCREs started to penetrate the regime. The next section will elaborate on this.

Small run-of-river generation plants also experienced a boom during recent years, mostly driven by the increasing availability of financing and the lessons learned in the sector across the years, especially with regard to how to work together with local communities. The government also put effort in smoothing the process for getting the necessary permits from the different governmental agencies and departments.

Biomass projects continued to develop, and though they have proliferated in the recent decade, this technology does not exhibit a boom in recent years and developments continue to be related to the industrial sector, that generates electricity from industrial waste as a side-product of their main activities. Other bio-energy generation sources have not been so far of much interest in the country.

Actors and institutions

Social organizations continued to work hard for advancing renewables in the country, particularly all the NCRE industry associations that had been created in recent years. They have worked along with the government for developing regulations that further facilitate the development of the NCRE sector, including the public tender regulations law modification and the development of the transmission law. They also were part of the committees that collaborated on elaborating the new long-term energy policy for the country, along with some environmental NGOs (though many of the latter decided not to participate in those conversations arguing a lack of agency on their part). These activities will be further described below.

In recent years the country has put more focus on the opportunity for developing the local industry in the energy sector. In 2014 the former CER was replaced by the Center for Innovation and Development of Renewable Energy (CIFES), which implied a particular switch of focus to an innovation strategy and started pushing the development of a local industry around the renewable energy sector. Later on in 2016, the CIFES was further replaced for a new committee of CORFO that will be focused on pushing the development of the local solar industry, which the country is now aiming to make a central economic sector for development. Indeed, the government sees the Atacama desert as a unique asset that can be exploited and utilized for fostering Chile’s development, and then multiple efforts are being put forth for advancing the development of the local solar industry (that so far does not exist as almost everything is imported), including R&D funding for innovation as well as funding for supporting entrepreneurial development. Though valuable, foreign experts seem to conclude that the solar niche might not offer the best possibilities, and tend to agree that a much less developed niche that also offers comparative advantages, such as marine energy generation technologies, might be a much better option to pursue. With all, technological development in the energy sector (and others) is still a pending challenge.

An important observation to make is that the transition in Chile has been enacted by entrepreneurs from the international and national private sector (and lately also by incumbent companies) rather than by grassroots initiatives, as it has happened in some European countries. The transition has then implied some de-concentration of the electricity generation market as new entrants has joined the sector, but incumbent companies still dominate and the traditional structure of a very concentrated market still remain. Indeed, the transition in Chile has not implied a shift towards more distributed small-scale schemes of electricity generation.

ii. Regime dynamics

Actors and institutions

By 2014, the new institutional structure of the sector was much more consolidated. The left-wing coalition —which had shown itself to be much more prone to supporting renewables than the right-wing one— regained the presidency in 2014, and that opened up the possibility for further changes in the regulatory system for favoring renewables' deployment.

In order to overcome the problem of financing, especially for getting access to PPAs, renewable energy developers (mainly through NCRE industry associations) had started to advocate for modifications in the regulations that ruled public tenders. In those tenders, generation companies used to bid on power blocks for supplying electricity to distribution companies that serve regulated costumers, which represent approximately 55% of electricity consumers. In 2014, when the new minister assumed office, NCRE developers' demands were heard and the legislation was modified accordingly. This change has been a recognized success by all actors in the sector, as energy prices have consistently and significantly dropped as a result of the increase in competition and the entrance of competitive NCRE technologies. Additionally, the legislation was modified for transferring the organization of public tenders for regulated consumers from the distribution companies, to the CNE.

As NCRE projects started to join the grid massively, transmission problems became apparent. Multiple zones started to suffer from bottlenecks, specifically in the northern part of the country where too many solar PV power plants had been recently installed, motivated by high radiation levels of the Atacama Desert. The transmission expansion sector lagged too behind development in the generation sector and that had caused congestion problems and slowed down investment. In addition, transmission projects also suffered from increasing opposition from local communities and private owners, which dramatically increased development times.

In 2014 the government started working on a transmission law that was finally passed in July 2016. Among the improvements in the sector is the interconnection of the two largest electricity systems in the country —the Central Interconnected System (in Spanish *Sistema Interconectado Central,* SIC) and the Norte Grande Interconnected System (in Spanish *Sistema Interconectado del Norte Grande,* SING), which together represent 99% of the electricity mix, which is expected to be ready in 2018/20019. The law established a single electricity system (called *National Electricity System*, in Spanish *Sistema Eléctrico Nacional*) as well as a single and independent coordination entity for the unified system (called *National Electricity Coordinator*, in Spanish *Coordinador Eléctrico Nacional*). It also establishes improvements in the transmission sector's planning. The sector now is going to be assessed every year by the Load Economic Dispatch Centers (in Spanish *Centros de Despacho Económico de Carga*, CDECs) and the CNE, and this would allow them to make recommendations to new entrants and incentivize/dis-incentivize developments in certain sectors, and that will help preventing transmission problems (though investment in the transmission sector will still be subject to private willingness to pursue it). Most experts and actors in the electricity sector expect that the bottlenecks and the majority of the transmission problems will be solved when the interconnection materializes, though its real impact remains to be seen.

Another major change in the sector was the elaboration of a long-term energy policy for the country. The government put effort in elaborating the policy through a participatory process that was to give legitimacy to the new energy sector strategy. The process lasted around two years, which included expert committees, policy committees (where they try to convene all stakeholders in the sector), and open working groups in all of the country's regions that convened the participation of the general public. The new *Energy 2050* policy was launched the last day of 2015 and sets four pillars as the core of Chilean energy policy vision: quality and security of supply, energy as a driver of development, environmentally-friendly energy, and energy efficiency and energy education. In addition to that, the document proposes the goal of achieving 70% of the Chilean energy mix to come from renewable energy sources by 2050 (including non-conventional sources as well as large hydroelectricity projects), and 50% by 2035. Though the process and the document have raised multiple critiques, particularly with respect to the participatory process and the lack of a roadmap of actions for achieving the proposed goals, stakeholders from all across the energy sector recognize its value and the step towards a novel and more participatory way of doing energy policy. This more participatory view has also reached the way in which the generation sector approaches project development. Indeed, considering the increasing conflicts that conventional energy technologies faced, several developers in the NCRE sector decided to adopt a different and much more inclusive way for developing their projects, that involves early approaches to local communities, for trying to integrate them into project planning and forming alliances that allow to unify forces and taking advantage of the generated synergies. This approach has been particularly characteristic of the NCRE sector, though in more recent years even incumbent firms have started to follow this path, perceived as the best (and maybe also the only) way to move forward with projects.

The new long-term energy policy strategy, along with the multiple institutional and regulatory changes that have taken place in the energy sector reflect a shift in the dominant policy paradigm. The new paradigm now allows for certain steering and planning of the energy sector on part of the state, something that was tried to be minimized under the previous purist market ideology that dominated the sector. The shift in the way of doing business in the sector is also an innovation that is setting a precedent for other infrastructure developments as well. Additionally, over time, sustainability started becoming a much more central issue and the new long-term policy embraces it as a core value.

One relevant observation to make is that Chile is a country highly influenced by international trends in all areas and in the energy sector in particular. As such, though in the early 2000 the concepts of environmental sustainability and clean energy generation were not preponderant in the country, when sustainability and climate change global trends started to emerge Chile (slowly) begun to embrace them, and so far they have also started to (slowly) penetrate other economic sectors in the country as well.

Actors and technologies

With regard to technologies, the regime continues to be dominated by large scale coal and hydro power plants, though it is increasingly getting contracted as a consequence of renewables' expansion. There has been an evident lack of new developments of these conventional energy technologies (especially due to social opposition), and projections show that this tendency will continue. As conventional energy technologies continue to raise massive opposition from local communities, and after witnessing the success of renewables' in the market, even incumbents have (slowly) started to switch to these technologies. This is in part due to the fact that major electricity generation companies in Chile are owned by international franchises that have started to switch their portfolios towards clean energy technologies.

5.4.2. Analyzing transition pathways

The previous section presented the Chilean transition in terms of the MLP approach. The characterization of regimes and niches and how they varied across time is helpful for looking at changes from a global perspective, which allows for the study of overall transition dynamics and multi-level interactions.

The presented description illustrates that change occurs through sequences of events enacted by actors. Events aggregate and link up giving birth to the different trajectories and alignments that can be interpreted trough the lens of the MLP. This highlights the fact that transitions can be analyzed with different levels of granularity, as noted by Geels and Schot (2010). In this section's analysis, I mix the interpretation at two different levels: the global multi-level approach, describing the overall dynamics of the transition that took take place within and between levels, and to more focused interpretation of pathways characterized in terms of actors, technologies and institutions. I do so as I think this enables to picture more clearly the dynamics of the Chilean transition.

Notably, as Berkhout et. al (2010) point out, making categorical distinctions (e.g. between niches and regimes) is often difficult because of the mutually constituting and co-evolving nature of actors and practices. Then, the categorization that follows should not be conceived as rigid but rather fluid, meaning that boundaries are blurry and allow for flexible interpretation.

The overall transition dynamics of the Chilean transition can be interpreted as follows. Back in 2004, the Chilean electricity sector was characterized by a neoliberal policy paradigm, relying on market forces for the governance of the electricity sector, with minimum government intervention. The crisis of the Argentinian gas in 2004 was the first big exogenous event (impacting the regime from the landscape) that started opening a window of opportunity for socio-technical change in the energy sector. The event made apparent the fact that the market alone would not necessarily yield the most convenient outcomes for society, and then steering the sector into desirable directions was imperative. Indeed, a series of regulatory, institutional and policy changes started to take place in the energy sector reshaping the dominant regime and welcoming a new policy paradigm.

From Chapter 3 we learned that certain social organizations were able to identify the opportunity for making change happen. Indeed, both environmental NGOs and NCRE industry associations can be seen as policy entrepreneurs that were able to take advantage of the window of opportunity opened up by a constellation of contextual factors and actors. Though motivated by different interests, they allied joining forces for pushing a common interest: the development of a new market for renewables in the country. In great part due to the push of social organizations, around 2007 the government started seeing renewables as a plausible solution for Chile's energy problem. The government then decided to sponsor a quota law that was expected to open the market for the entrance of such technologies. The law faced important opposition, but in the end was massively supported by Congress, in part due to the acknowledgment of the energy crisis that the country was facing. The landscape then impacted the regime through the crisis event, the opportunity was identified by policy entrepreneurs who were able to align forces so as to take advantage of the opportunity for opening up a space for the creation of niches, on the basis of expectations and visions. Taking advantage of the window of opportunity that the energy crises had opened up was marked by power struggles due to the resistance of incumbent firms to the entrance of new competitors, though the alignment of forces on part of the government and social organizations (environmental NGOs and NCRE industry associations) in an advocacy coalition enabled the quota law to move forward.

At the same time, we know that the immediate and cheapest solution for the crisis was to switch to coal thermoelectricity generation. This triggered multiple pollution scandals in different parts of the country but especially in northern Chile. On top of that, environmental groups organized opposition against the development of hydroelectric power plants to be built in the Patagonia region. All these raised massive opposition on part of environmental groups, local communities and the civil society in general, against the development of conventional electricity power plants. Such opposition was so strong that by the end of the last decade it was very difficult to develop conventional electricity generation projects in Chile.

Both the quota requirement that the government implemented, as well as the massive opposition that the civil society in general raised against conventional energy technologies preventing their development created a protected space were new projects of NCRE technologies started to be developed. As mentioned before the first successful pilot projects were financed by multilateral organizations. After that, many international developers got interested in the Chilean electricity market attracted by the availability of natural resources, the high energy prices and the country’s good business environment.

Smith and Raven (2012) argue that protected spaces (or niches) provide new technological projects with shielding, nurturing and empowerment. Shielding involves processes that hold off selection pressures, such as the quota law and the massive opposition towards the development of conventional energy projects mentioned above. Indeed, using Smith and Raven's (2012) concepts, civil society and communities' opposition can be interpreted to have contributed to the creation of a *passive shielded space*, defined as one where the selection pressures are felt less keenly for contingent rather than strategic reasons, and in a sense precede mobilization by advocates. On the other hand, the quota law created an *active protective space*, that is, one that resulted from the deliberate and strategic creation by advocates of specific path-breaking innovations to shield regime selection pressures. The second quota law that was passed in 2013 further contributed to the creation of that protected space. Importantly, while the first quota law was proposed and passed on the grounds of positive expectations, the second one was supported on both successful pilot examples and positive future expectations.

Nurturing involves processes that support the development of innovation. Drawing from the literature on product/industry life cycles, the TIS approach has identified a set of elements that the formative phase of technological systems comprises, which allows markets to start developing: institutional change, market formation, new entrants, and advocacy coalitions. In Chapter 4 I reviewed how the role that the Chilean government played favored the occurrence of each of the four elements (institutional change, market formation, new entrants, and advocacy coalitions), which coupled with the actions of societal organizations, namely environmental NGOs and industry associations (see Chapter 3), that sought to advance renewables' deployment. Such actions came from actors in the regime (governments and NGOs) as well as from new entrants (new NCRE firms), which aligned for boosting niches' development.

Smith and Raven (2012) argue that empowerment involves processes that make niche innovations competitive within unchanged selection environments (fit-and-conform pattern) or processes that make mainstream selection environments favorable to the path-breaking innovation (stretch-and-transform pattern). Up until the end of 2013, the transition in Chile followed a fit-and-conform pattern, which occurs when innovations with better price/performance characteristics disrupt existing technologies, though they are developed to fit existing rules and institutions and then only limited institutional change takes place. This empowering occurred through the alignment of different elements that allowed niches (pilot experiments) to develop: the availability of renewable energy resources, the high prices of energy in the country, the strong oppositions on part of local communities to conventional energy projects, the existence of a stable regulatory framework, the regulations and supporting policies implemented by the government, increasing financing availability, promising energy demand expectations, and the improvements in new technologies in terms of efficiency as well as their decreasing technology costs, among others. In particular, the massive opposition to conventional energy technologies, beyond having contributed to the creation of a (passive) protected space, can be interpreted as pressure exerted by an exogenous force (civil society mostly, though coordinated by policy entrepreneurs coming from the regime) that influenced the empowerment/development of niches, making them competitive indirectly, by raising entry barriers to incumbents.

The alignment of the aforementioned elements allowed the internal momentum of niches to increase. This is how from 2014 onwards the Chilean transition started to experience a boom of NCRE projects, and the associated innovation pathway it was following can be seen as shifting from a fit-and-conform pattern towards a stretch-and-transform pattern. Such a pattern implies the creation of new rules and institutions that needed to be adjusted to suit the niche-innovation (Smith and Raven, 2012). Indeed, at the time, the renewables' sector started to bounce into the regime, exerting pressure to change key regulations and policies. NCRE industry associations were able to put pressure on the regime so as to push the government to make significant changes in the regulatory scheme for allowing the further development of the sector, through the change in regulations of public tenders for allowing renewables to access the market of regulated consumers, and then reforming the existent transmission law. This pictures the relevant role that industry associations, acting as policy entrepreneurs, played in the transition by taking advantage of the openness that the left-wing government (which has recently regained the presidency) had towards the development of the renewable energy sector in the country. This is how the emerging NCRE technology sector was able to start breaking through, taking advantage of the opportunity that a long energy crisis had opened. According to Geels et. al (2016), this process is likely to cause power struggles, socio-political mobilization and counter-mobilization (Geels t al., 2016; Geels, 2014). Such power struggles and mobilization were studied in Chapter 3, which explored in detail the politics of the process. It is worth mentioning that though the NCRE sector still reports that it faces considerable resistance from incumbent firms and that shows that power struggles have been always present, the regulatory and political changes that started reshaping the regime did not face much resistance as the ones that had occurred before (mainly the first and second quota laws). This is likely to have been the case because of the momentum that renewables have gained and the convenience and benefits that the sector have started to show, but also because incumbent firms have begun to enter the renewables sector (this point is further elaborated below).

Further adjustments in the socio-technical regime have also taken place. The Chilean transition to renewables has occurred along with a process of general institutional transformation in the sector, which was triggered by the energy crises that Chile faced. This ongoing process has involved a policy paradigm changethat has comprised changes in the way energy policy is conceived in the country, shifting from a predominant neoliberal regime to one that now allows for more steering and planning on part of the state. Indeed, the existence of this ongoing process of institutional transformation is likely to have made it easier for NCRE policy entrepreneurs to push forward the changes they were seeking to achieve.

Importantly, the change in the policy approach and institutions that the energy sector has been experiencing has arguably also started to influence the landscape in different dimensions affecting for example the neoliberal discourse that dominates the political sphere, highlighting the need for more participation in policy-making and for the development of a land-use management policy.

Both the fit-and-conform and the stretch-and-transform pathways are classified by Geels et al. (2016) as part of the so called substitution pathway, that is, one that involves the struggle of innovations introduced by new entrants (firms) into an established regime dominated by incumbent firms. As it was explained, the Chilean transition has exhibited characteristics of both of them so far, but more recently it has also started to show features of a transformation pathway, characterized by the reorientation of incumbent firms towards the incorporation of new innovations. Geels et al. (2016)

argue that this reorientation process may occur either incrementally, meaning that incumbents might incorporate incremental improvements in exiting technologies or symbiotic niche-innovations and add-ons, or substantially, that is, incumbents may reorient towards the use of radically new technology or, even more deeply, to new beliefs, mission, and business model which might lead to partial or full reorientation of the regime towards new technologies.

5.4.3. Assessing theoretical fit to the case

We have seen that the MLP framework offers a useful scheme for analyzing the overall dynamics of the Chilean transition. As the framework has been advanced by researchers over the years, it now accounts for multiple interactions that might exist between the different levels (macro, meso and micro). Geels (2011) noted that an important feature of the MLP framework is that it recognizes that transitions are not characterized by a single cause of driver, but that they comprise multidimensional processes at different levels which link up with and reinforce each other.

The experience of the Chilean transition suggests some possible additional interactions that might occur, which do not appear to be fully accounted for by the MLP. Putting it simply, the MLP model comprises the development of niche-innovations, which might build up internal momentum and take advantage of the window of opportunity that a destabilization of the regime might create, as a result of changes at the landscape level that may put pressure on the regime. The Chilean transition, as it has been previously noted, involved the adoption of new technologies that had been developed by European countries, but there was no local technology development happening in Chile, neither the creation of a local manufacturing industry related to the sector. As technologies had been developed in other countries, in the case of the Chilean transition, the innovation niches corresponded to pilot projects (in the traditional sense, as opposed to niches that involved technological development). So in the case of Chile, the story almost starts with an exogenous pressure exerted on the regime, namely the Argentinian energy crisis, that opened up a window of opportunity for socio-technical change unleashing a restructuration wave in the sector. That event ended up enabling the implementation of the quota law pushed forward by a strong advocacy coalition, which influenced the space for niche development, giving renewables a chance on the basis of expectations and visions. Notably, as concluded in Chapter 3, policy entrepreneurs were crucial actors in the process of taking advantage of windows of opportunity for socio-technical change.

Since the Chilean transition has only involved the adoption of new technologies, the timing for niche development was much shorter compared to countries where technological development processes take place, as it has been the case in some developed countries. In the process of niche development the social opposition to conventional energy technologies coming from local communities and the civil society in general provided both shielding (by raising entry barriers to traditional technologies) and empowerment (by indirectly helping to make NCRE technologies more competitive, as their opposition prevented conventional energy projects to develop contributing to keep energy prices high) to the regime. That corresponds again to an exogenous force intervening into niche development.

When NCRE technologies had gained enough credibility and acceptance, and the internal momentum of the sector's development had increased, niches started irrupting into the predominant regime. This process involved power struggles, though much less intense that the previous ones, as arguably incumbent firms had started to see a business opportunity in the new technologies. Again this time the changing process was pushed forward by key policy entrepreneurs (mostly industry associations).

The window of opportunity for change in the sector opened up by the crisis with Argentinian gas imports, remained open for several years in great part due to the severe drought that affected the country from 2007 to 2014 approximately. In the mean time, a whole restructuration process took place on the regime, which also contributed to make it easier for entrepreneurs to push forward the regulatory changes that have favored renewables deployment in the recent years.

Figure 5.2 depicts a modified version of the MLP that accounts for the dynamics involved in the Chilean transition.

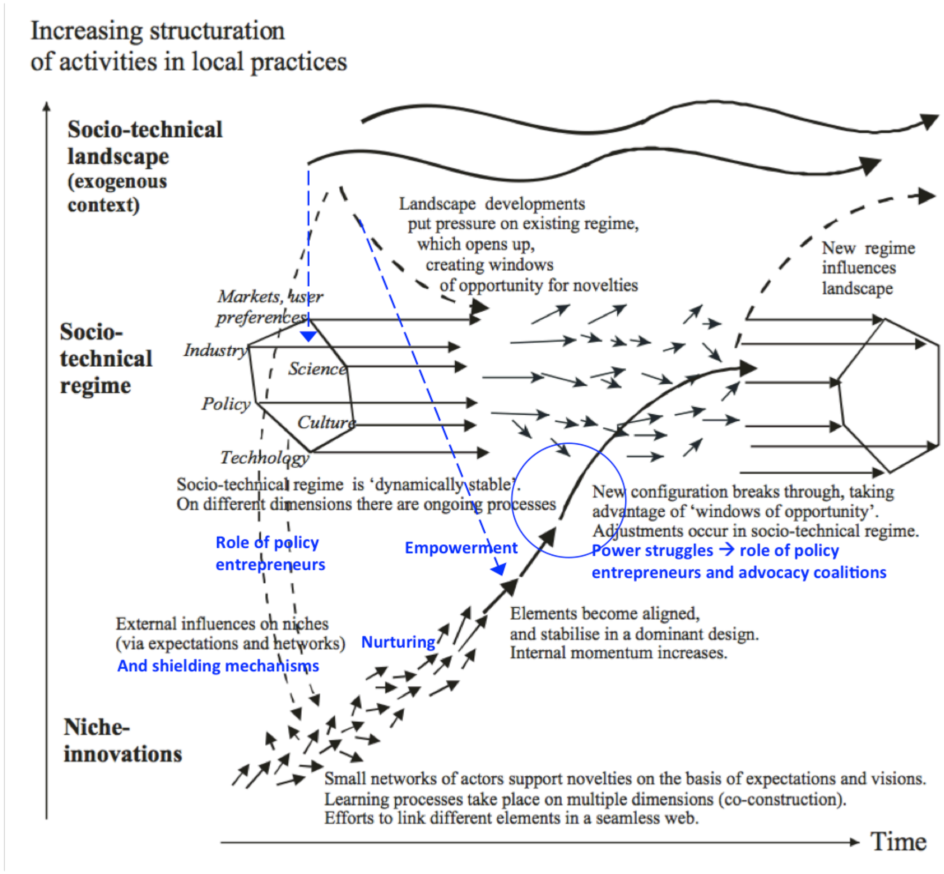


Figure 5.2. Adapted version of the MLP to accounts for the dynamics involved in the Chilean transition.

In terms of the (reformulated) transition pathways proposed by Geels et. al (2016), the Chilean transition is all over the place mixing substitution and transformation pathways. At first it followed a fit-and-conform pattern, which then shifted to exhibit some characteristics of a stretch-and-transform one, though new entrants have only been new firms, instead of less traditional developers, as the typology defines. In recent years, incumbent firms have started to shift towards the incorporation of renewables —indeed, the shift to a stretch and transform pattern might also have occurred in part due to this—, which exhibits characteristics of a transformation pathway (happening in parallel) with incumbents reorienting incrementally but substantially. The Chilean transition pattern does not quite fit in the descriptions provided by Geels et. al (2016) though.

With all, the analysis suggests that first and foremost both the typology of transition pathways proposed by Geels et at. (2016) provide a useful language for studying transitions. Regarding the typology of transition pathways, the Chilean case suggests that it provides a set of possible pathways that transitions might take, but it does not account for all possible scenarios. Moreover, it is likely that as transitions unfold and are studied in different countries, the universe of possible pathways diversifies and expands along with them. Rather than being used as a set of all possible strictly defined pathways that a transition may follow, I argue that the typology might be better understood as a collection of possible orientations gathered from experience and research that helps understand and explain how transitions may unfold.

As Smith et al. (2010) point out, the MLP provides a helpful way for ordering and simplifying the analysis of complex, large-scale structural transformations, which is illustrated by the analysis of the Chilean case presented above (contrast it with the chronological description of events elaborated in Chapter 2). The approach also offers both a useful framework and language for analyzing transitions in the overall dynamics of transition processes, though the scheme has been informed mostly by transition processes that have taken place in Western European nations. A difference that emerges when applying the framework for analyzing the Chilean case is that, since the transition in Chile has not involved technological innovation, the order of the different events that are characterized in the MLP seems to be different, with the niches' development process taking much less time for unfolding.

As both the MLP framework and the typology of transition pathways corresponds to models that attempt to represent reality, boundaries between levels and proposed pathways are likely to be difficult to identify, and then it should be preferable to understand them as fluid rather than as rigid and strictly defined.

Overall, the interaction of actors and factors in the Chilean transition might be visualized as a seesaw of net-countervailing forces. On one side are all forces that enabled and pushed for NCRE technologies deployment in Chile. On the other competing side are all actors and factors that have resisted technological change. So far, the balance of all these interacting forces is tipping the scale in favor of renewables. Figures 5.3 shows the net-countervailing forces interacting in the Chilean transition.

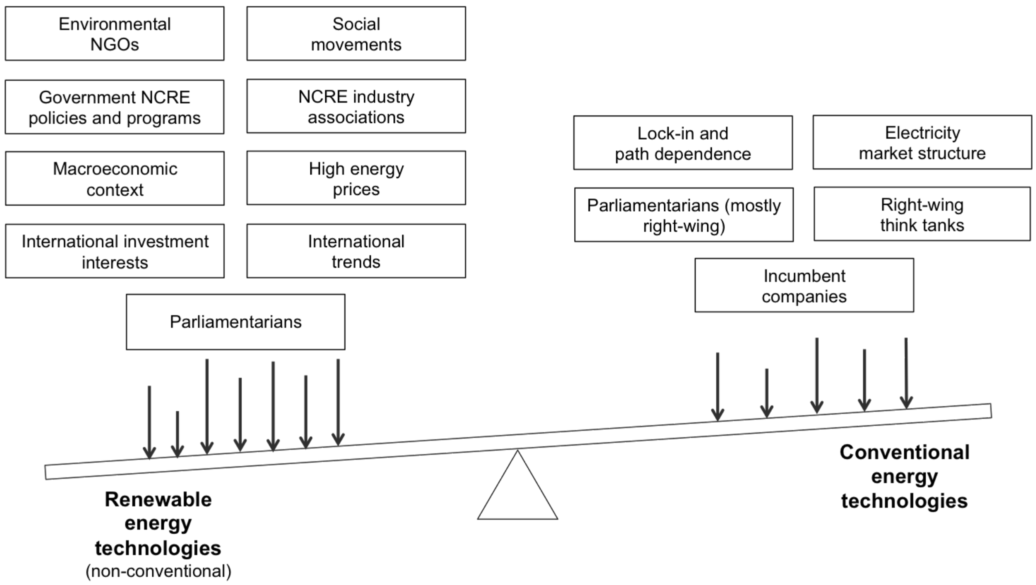


Figure 5.3. Net-countervailing forces interacting in the Chilean transition.

5.5. Discussion: theoretical contributions from a developing country's perspective

5.5.1. Comparison with Germany and the UK electricity transitions

In order to put the Chilean transition in perspective I compare it in terms of transition pathways to the German and UK electricity transitions based on a characterization elaborated by Geels et al. (2016).

Using their proposed typology Geels et al. (2016) argue that the German transition followed a substitution pathway. The German transition involved a competition between small-scale renewable energy technologies (solar PV, biogas, small onshore wind) and regime technologies, characterized by different knowledge basis and operational principles (decentralization). The German renewable energy deployment was enacted by radically new entrants (citizens, cooperatives, environmental activists, farmers, municipal utilities), who were firstly inspired by social, environmental and anti-nuclear motivations, and afterwards by financial motives. Renewable energy technologies' deployment was also supported by coalitions formed by industrial associations from the metal and machine-building sector, renewable energy manufacturers, and policymakers interested in green jobs. The 1990 Feed-in-Law offered protection for new entrants and small-scale renewable energy deployment (mainly wind).

Later on, the 2000 EEG stimulated wider diffusion of renewable energy technologies “unleashing” new entrants. Several landscape characteristics contributed to make the German transition possible: (i) the existence of a strong and organized civil society with active cooperatives, citizen groups, activists, and socially engaged scientists, (ii) the collaborative tradition for stakeholder interaction of Germany’s ‘coordinated market economy’ (Hall and Soskice, 2001), which in various instances led the government to accommodate civil society pressure (e.g. protests in the late 1990s against proposed cancellation of the Feed-In-Law; demands for more renewable energy technologies’ support in the 2000s; protests against nuclear power and shale gas in the early 2010s), (iii) the ability of the red-green government to disrupt the traditional close interactions between utility incumbents and the government, (iv) the German strong environmentalist tradition (Dryzek et al., 2002), which helps explain the cultural resonance of the renewable energy discourse and the presence of a Green Party in Parliament, and (v) the existence of substantial manufacturing sectors, which meant that German firms could benefit economically from the electricity transition (e.g. building wind turbines, solar PV modules), with the creation of jobs and new industries argument contributing to build supportive coalitions and a credible ‘green growth’ discourse.

In the UK case, Geels et al. (2016) argue that the transition has so far followed a transformation pathway, with renewable energy technologies being implemented mainly by incumbent utilities, professional project developers and other corporate actors, motivated by commercial interests and regulatory compliance. Regulatory policies have focused on incentivizing incumbents to deploy renewable energy technologies rather than enabling new entrants, with several auction and trading schemes even creating barriers for the entrance of new firms. The 2010 Feed-In-Tariff, the 2013 Solar PV Strategy and the 2014 Community Energy Strategy are recent add-on policies, aimed at small-scale renewable energy technologies which complement rather than disrupt the focus on large-scale options (nuclear, offshore wind, CCS). These conditions help explain why renewable electricity mainly comes from large-scale renewable energy technologies (offshore wind, onshore wind, conversion of coal plants to biomass, landfill gas), which required new technical knowledge but fitted with centralized operational principles and business models of incumbents. In addition, Geels et al.

argue that some characteristics of the UK (static) landscape help further explain the followed transition pathway: (i) the Westminster political system characterized by close-knit policy networks that are relatively open to incumbent industry actors but remain closed for outsiders and new entrants (Bailey, 2007) and facilitate an autocratic top-down policy style, (ii) the 'liberal market economy' (Hall and Soskice, 2001) characterized by a neo-liberal ideology which explains the preference for market-based and non-technology specific policy instruments creating barriers for new entrants, (iii) the fact that the civil society has been weakened since the 1980s (Marquand, 2004) and (iv) that UK only counts with a small Green Party, (v) and the difficulties for developing a credible green industrial strategy given the fact that UK has recently lost many manufacturing industries.

The case of Chile is different from both the German and UK cases. First of all, in contrast to the German case where most of the technologies were locally developed, the process of transition to renewables in Chile has only involved the adoption of new technologies previously developed in Europe. Figures 5.4 and 5.5 show respectively the evolution of wind and solar installed generation capacity in Chile as percentage of national energy mix penetration. Figures 5.6 and 5.7 show the evolution of solar installed generation capacity in Germany as percentage of national energy mix penetration (note that even when the graph is not able to show it, wind turbines started to penetrate the German market in 1985, according to Jacobsson and Lauber's (2006) data). When contrasting the figures, the difference in timing is evident; with the Chilean case developing in much less time than the German one, as the former limits to the adoption of already mature technologies, while the latter involved the development of both wind farms and solar PV technologies across the years.

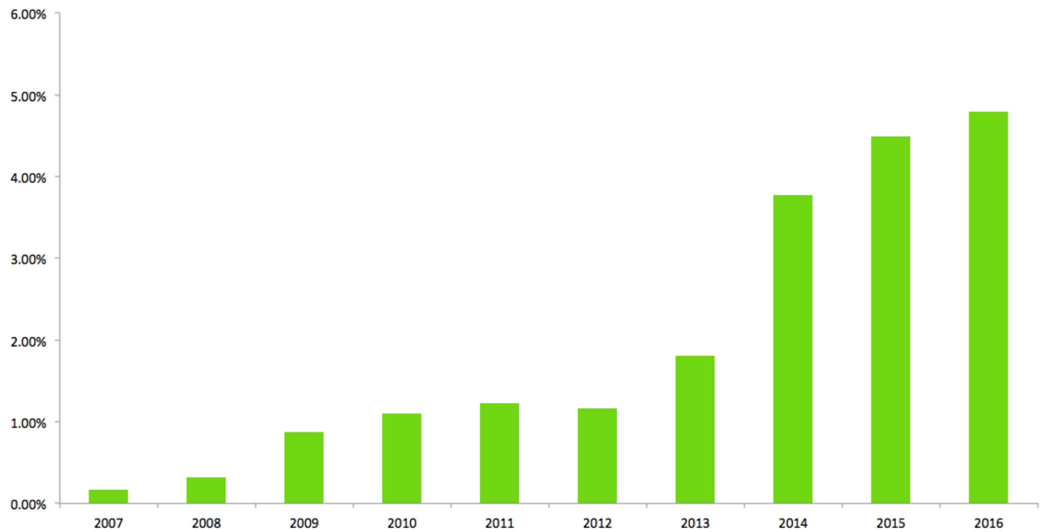


Figure 5.4. Evolution of wind installed generation capacity in Chile as percentage of national energy mix penetration. Data retrieved from CDEC SING and CDEC SIC.

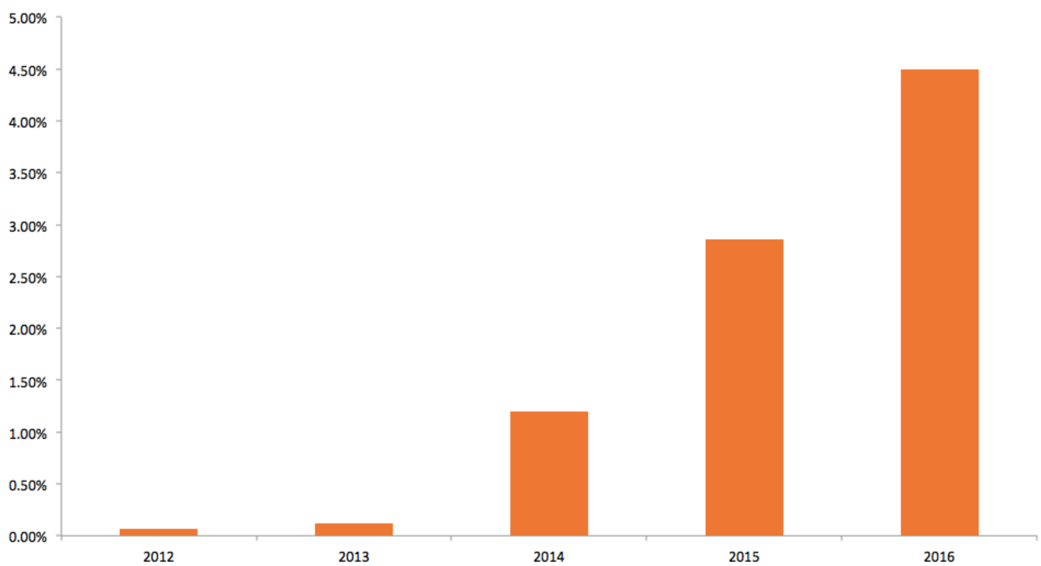


Figure 5.5. Evolution of solar installed generation capacity in Chile as percentage of national energy mix penetration. Data retrieved from CDEC SING and CDEC SIC.

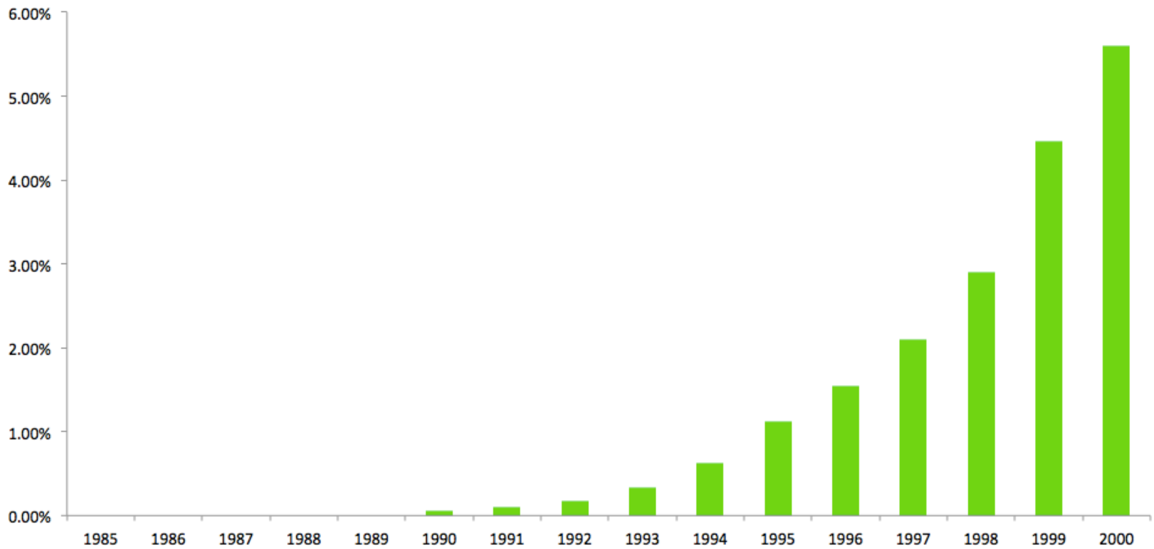


Figure 5.6. Evolution of wind installed generation capacity in Germany as percentage of national energy mix penetration. Data retrieved from: Jacobsson and Lauber (2006), UNData.

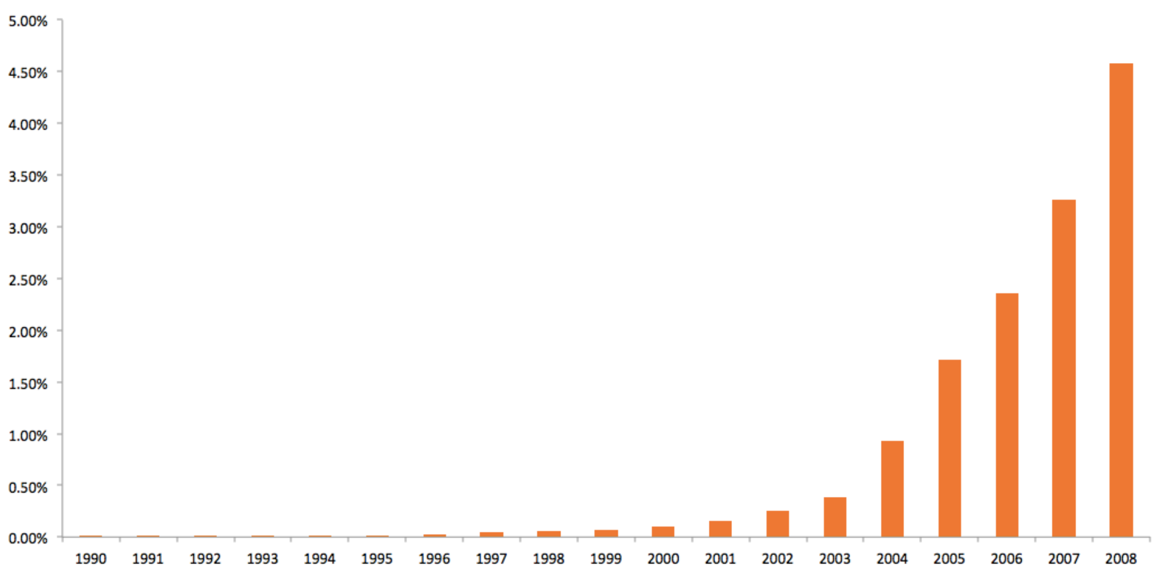


Figure 5.7. Evolution of solar installed generation capacity in Germany as percentage of national energy mix penetration. Data retrieved from: Jacobsson and Lauber (2006), UNData.

Like the German transition, the Chilean transition also exhibits characteristics of a substitution pathway. In the German case the transition was enacted by new entrants deploying small-scale renewable electricity technologies; in Chile the transition was enacted by new entrants importing renewable energy technologies from abroad for mid-size projects. More recently the German transition is argued to have shifted from a 'stretch-and-transform' substitution pathway to a 'fit-and-conform' pathway, because of a fightback from utilities and altered institutions. The Chilean case seems to exhibit a backwards pattern shifting from a 'fit-and-conform' to a 'stretch-and-transform' pattern as the renewable energy sector has grown. This has also been in part due to the fact that incumbent companies, seeking business opportunities, have recently started to diversify their portfolios by increasing the share generated by renewables, which seems to reflect the characteristics of a transformation pathway (happening in parallel), with incumbents reorienting incrementally but substantially towards the use of clean energy technologies. Germany and Chile have in common that none of the two countries have abundant fossil fuel resources, which is something that Kuzemko et al. (2016) point out as a common factor of countries that are more likely to develop an energy vision associated to renewables. In contrast, in countries that have indigenous fossil fuels, energy companies have over time made considerable financial contributions to GDP and have employed large numbers of people. Moreover, because of the material importance of fossil fuels to economic development in the 19th and 20th centuries, some scholars have linked generous domestic endowments of coal and oil to global economic power and influence (Strange, 1988). The latter has been the case of the UK, where the transition has been characterized by a transformation pathway, enacted by incumbent actors deploying large-scale renewable energy technologies. In recent years the UK transition has arguably moved from moderate to substantial incumbent reorientation, as government policies became stronger. However, more recently, further policy changes have substantially downscaled UK renewables' support, which is likely to shift the transition back to a weaker reorientation. In the Chilean case, I argue that if the transformation pattern continues to develop, that is, incumbents continue to reorient towards renewables and start acquiring the new firms and projects that have entered the sector (examples of this have already started happening), the transition runs the risk of getting captured by incumbents and shift towards a more traditional approach to renewables (e.g. preferring hydroelectric technologies).

In their analysis, Geels et. al (2016) note the importance of the landscape for the transition. In the cases of both Germany and the UK, contextual factors (landscape) determined the transition in great way. In common with the German case, the Chilean transition also exhibits a preponderant role of social organizations and the civil society in the transition (landscape actors), which has led the author to highlight the role of policy entrepreneurs as central actors of socio-technical change processes in Chapter 3. At the same time, in contrast to the UK case, Chilean policy entrepreneurs (many times along with the government) were able to take advantage of the window opportunity for policy change that opened up in the regime, even though the landscape was also characterized by an energy sector that used to be dominated by a neoliberal market ideology and a group of few incumbent companies.

5.5.2. Transition dynamics in developing countries

The dynamics of transitions in the developing world have been much less studied than those happening in industrialized countries. Though all transition cases are deeply context-dependent and likely to be different, there are some insights from the Chilean case that might be useful for both understanding developing countries' transitions and to develop guidelines that allow countries to start managing/steering them. While I acknowledge that a multiplicity of factors involved in Chile's case were exogenous to the established regime and deeply characteristic of the Chilean landscape and then cannot be reproduced, there were others that allowed for agency on part of actors. In Chile, the transition was triggered by a crisis event, and the alignment of a series of factors made possible the increasing shift towards the use of renewables to start happening. The question is: is it possible to reproduce to a certain extent some key factors that might trigger and start building up a transition in other developing countries?

The Chilean case suggests that a transition in a developing country may start with the adoption of new technologies (as opposed to the development of new ones), which may imply a much shorter time-frame for the unfolding of the transition process. This is not to say that the advice for developing countries would be to rely on developed nations' technological progress indefinitely, but it suggests that it might be a good option to start with the adoption of cleaner technologies (which will be mostly imported) and then transitioning to the adaptation of technologies to local realities and then to developing local innovations, as Chile is starting (and hopefully continues) to do. Such a strategy might be more suitable for coupling with the reality of the developing world and the urgency of unleashing a sustainability transition in a quick time frame, while paving the path towards local (sustainable) development. This would modify the classic diagram of the MLP to reflect new relationships at different timings, as it was the case of the Chilean transition illustrated in Figure 2.

The case of Chile highlights the role of agency in transitions. Chapter 3 explored how policy entrepreneurs have pushed the transition forward. Indeed, social organizations (environmental NGOs and industry associations), at moments in alliance with the government in office —acting as policy entrepreneurs— have been able to organize and join forces to make the shift towards renewables to start happening. This speaks about how forces coming from the regime as well as new entrants, were able to put pressure on the regime for opening a space for niches to start developing. In that sense, the MLP diagram might start with a regime struggle, as it was the case of the Chilean transition. But then, which window of opportunity for policy change might entrepreneurs in other countries use? Though far from being a definite answer to this question, at least in the electricity/energy sector the increasing need for such resources in countries in development might offer an entry point. In particular, in the Latin American and the Caribbean region, energy (and infrastructure projects in general) have been facing increasing social and environmental conflicts in recent years, which many times have ended up with projects being cancelled or postponed. This situation is similar to what Chile has faced, where part of the interest and support for renewables emerged from the opposition that communities and the civil society raised against conventional energy projects. Renewable energy projects, if planned and developed appropriately following sustainability principles, might offer a more socially desirable alternative, which countries may want to seek given the increasing energy needs they face. Other windows of opportunity are to be identified in light of the different countries' contexts.

Chapter 4 shows how the government has enabled in great part the transition through the implementation of policies and regulations. Though Chile did not implement subsidies for incentivizing renewables' deployment, it did pass a quota law for start opening the market to renewables. The government also implemented a set of complementary policies that fostered and enabled the occurrence of the elements that characterize the formative phase of a technological innovation system: institutional change, market formation, new entrants, and advocacy coalitions. Along with that, the Chilean energy governance sector started experiencing a deep reformulation process that comprised a new vision for the sector, which reflects a much strategic planning and sustainable approach that tries to find a balance between giving space for market development and the necessary steering of the sector. In addition, the energy governance sector underwent a deep expansion of its existent institutional capacity. This latter point is particularly important, as the lack of institutional infrastructure characterizes the developing world. In addition to the aforementioned factors are some key landscape attributes, such as the fact that Chile is characterized by a good business environment and a (relatively) strong rule of law. In light of the above, it might be helpful for policy-makers and practitioners in developing countries that sustainability transitions' experts identify a set of policy recommendations and best practices that governments and governance entities might be able to pursue for triggering and enabling a transition, much like the functions approach that the TIS literature has developed (see Bergek et al., 2008).

In the Chilean transition, both policy entrepreneurs and the government played fundamental roles in the transition process. As Chapter 3 points out, social organizations acted as policy entrepreneurs in the process, working as indispensable idea-promoters and coalition builders, while as it was analyzed in Chapter 4, the government enabled the process by facilitating the emergence of a renewables' market (in great part pushed by entrepreneurs). I argue that as both entrepreneurs and governments are likely to play fundamental and indispensable roles in other transition processes as well (in Chile and other countries), given the depth of the socio-technical changes that transitions necessarily comprise and the magnitude of power struggles that they are likely to involve.

Compared to other transitions taking place in developing countries, the research study presented in this dissertation is in line with Solomon and Krishna's (2011) study of the Brazilian transition towards the use of sugarcane-based ethanol to substitute imported petroleum for transportation fuel. Though following different strategies, both the Chilean and Brazilian cases highlight the role that governments may play in triggering and leading transitions in developing countries. Both transitions have resulted in great part due to the implementation of adequate policies that have allowed for the creation and strengthening of a market but at the same time have offered the necessary space for governmental steering. Moreover, both cases were originally triggered by an exogenous crisis that opened a window of opportunity for socio-technical change that policy entrepreneurs were able to take advantage of.

Other researchers have studied transitions in happening in Asian countries. Such research is centered in sustainability experiments taking place in in Indonesia, China, Bangladesh and the Philippines that have been implemented at small scales and now face the challenge of scaling-up. Researchers have noted that successful experiments face multiple constraints that prevent institutional upscaling from happening, finding it difficult to push for the needed institutional change that allows for experiments to be up-scaled to a national level. This speaks about the critical role of linkages between different levels in socio-technical systems for enabling the emergence of sustainable development pathways (Bai et al., 2016). Actually, precisely the absence of such linkages between local initiatives that promote sustainability and national level policies in many Asian contexts is an important factor obstructing sustainability transitions in Asia (see discussion in section 5.2.4). The case of Chile is different from those in the sense that in Chile the transition started with niches being created as a result of pressure coming from both the landscape and the regime. Indeed, the transition itself took place as part of a deep restructuration of the country's energy sector. This may have made institutional and regulatory change easier to happen, as the regime was navigating a more fluid (rather than stable) stage.

From the study of transitions happening in Asian countries, Berkhout et. al (2009) have argued that more sustainable development pathways than those of previous cases of industrializations are possible, though examples have not been witnessed yet. Chile, despite the progress made in its electricity generation mix, still faces the pending challenge of sustainable development. This would imply not only a change towards the use of clean energy technologies, but the also the achievement of a more sustainable economy in general; one that embraces all sustainability dimensions (including economic, social, environmental, and institutional sustainable practices) and that involves a departure from the country's current resource-based economic pattern towards a more knowledge and service-based economy. The country is starting to concentrate efforts in pushing the development of the local solar industry (mostly focusing on research and development), but available support is rather modest, and solar might not even be an appropriate niche to focus one. With all, identifying conducing pathways towards sustainable development is still a challenge to the developing world.

One important aspect of the Chilean case relates to the relevance of international influence in the transition process. This is another weak aspect of the MLP, that tends to hide in the landscape level both national and international influences making it difficult to identify and differentiate them. International influence has been materialized in two main fronts: ideology and technology transfer.

With respect to ideas, Chile has been influenced by environmental science and policy approaches coming from the North, especially Europe. Environmental NGOs and NCRE industry associations, who acted as policy entrepreneurs, were inspired by ideas and knowledge from developed countries, received resources from international organizations for campaigns that they led and were supported in knowledge generation processes (e.g. the development of studies). The government also looked at experiences in the developed world for evaluating possibilities for Chile, and received assessment from the German GIZ for the development of renewable energy policies and programs. Even with time, as climate change and sustainability trends gained strength, the government opted for incorporating them. The Chilean experience seems to be in line with Steinberg's (2001) findings from his studies on the emergence of environmental policies in Costa Rica and Bolivia, which underscore the importance of policy entrepreneurs in taking advantage of windows of opportunity for pushing environmental policy change, as well as the relevance of international ideas and resources in triggering and supporting that change.

On the technology side, Chile might be seen as receiving a bundling package of knowledge, technology and financing. First of all, the transition in Chile has been mostly materialized by international companies that came to the country in search for new markets, motivated by the diminishing of subsidies in the solar sector or in search for new markets in the case of wind energy. At the beginning, funding sources also came from abroad, from international developers had access to direct sources and from development organizations. Moreover, the fact that the Chilean transition did not comprise the development of technology implies that most equipment was imported, as well as the know-how for operating it. All this evidence (again) underscores the influence that the developed world might have in unfolding transitions in the South and recalls the discussion developed in section 5.2.4 on technology transfer processes. That review analysis noted that technology transfer processes from developed to developing countries might be more or less effective (for boosting development and/or technology change) depending on different characteristics of the recipient environment. Among the main factors that enable successful technology transfer are the existence of adequate institutional and economic frameworks, large and stable demand, appropriate absorptive capacity, and supportive policies. A brief analysis of Chile's experience indicates that the country has been successful in terms of the establishment of a NCRE generation sector exhibiting most of the aforementioned factors, but it has rather failed in terms of creating a local industrial sector, especially for not having adequate human capital nor appropriate policies for supporting local technological development. This points towards future aspects to address in attempting to move in such direction.

Certainly, the analysis of international influences requires further research and a much deeper analysis, though it was not prioritized in this study at the expense of other topics. Despite that, this quick overview of ideological and technological influences allows for highlighting the impact that the developed world and the international community may have in triggering and supporting transitions in the South.

5.6. Conclusions

Sustainability transitions theories are useful for understanding the dynamics of the ongoing electricity transition to renewables in Chile. The MLP model in particular provide a helpful approach for making sense of changes and interactions at different levels. The typology of transition pathways proposed by Geels et. al (2016) is also useful for understanding the Chilean transition, which can be firstly characterized by a substitution pathway following a fit-and-conform pattern, that is, expecting renewables to be able to compete with others in the market; and then shifting to a stretch-and-transform pattern, characterized by the adjustment of rules and institutions to suit the incoming innovations. In recent years, characteristics of a transformation pathway can also be identified in Chile's story, as incumbents have started to enter the renewables' market persuaded by the business opportunities that the sector is offering.

Both the MLP model (at an overall level) and the typology of transition pathways, —which takes a closer look on the interactions between actors, technologies and institutions— provide a useful language for analyzing transition dynamics, though neither of them fully accounts for the interactions happening in the Chilean case. Beyond the specific modifications that the case may require, this overall suggests that available theories might be better understood as analytical tools that may provide a language and offer a flexible framework for the understanding of transitions' interactions, instead of being conceived as rigid models that attempt to account for all possible cases. Indeed, the complexity of socio-technical transition processes suggests that only flexible, fluid frameworks would be able to accommodate for the multiple variations that transitions in contrasting contexts from developed and developing countries are likely to incur.

While acknowledging the fact that transitions are necessarily context-dependent, I draw some insights from the Chilean case that might shed light to the understanding and management of transitions happening in developing countries. One feature of the Chilean case is that the transition has so far only involved the adoption of new technologies developed elsewhere, and then the process has been much shorter than in other countries, where transition processes have comprised technological innovation, as it is the case of the development of solar PV technologies in Germany. Chile is now aiming to transition towards the development of a local industry around the solar energy sector, starting with the adaptation of imported technologies, which might represent a first step towards local technology design and manufacturing. There might be though, other more promising options besides entering the manufacturing industry of renewable energy technologies, related to other parts of the value chain of the electricity industry as it is, for example, focusing in software development or systems modeling. In any case, the transitioning model that Chile is following might represent an attractive option for developing countries, offering a transitional approach towards technological development pushed by a market of clean technologies. As discussed in Chapter 4, considering alternative economic models (rather than only focusing on import substitution strategies) might offer valuable insight for ideating a strategy to move forward. With all, and there is a long way to go before start witnessing the first results of Chilean efforts and sustainable development remains a pending challenge.

Despite the complexity and context-dependency of socio-technical transition processes, the Chilean case allows for the recognition of certain agency elements that played a relevant role in enabling the transition to start happening. Chapter 3 made apparent the key role that policy entrepreneurs, mainly from social organizations, played in triggering and lobbying for enabling the transition to happen. Chapter 4 also made clear the crucial functions performed by the Chilean government for both enabling a market for renewables to start emerging, while switching the energy policy approach of the country towards one that now considers steering and planning components. The central role that governments may play in enabling transitions is also illustrated by the Brazilian transition towards the use of bio-ethanol from sugarcane in transportation, and it is also highlighted by the hurdles that transitions in Indonesia, China, Bangladesh and the Philippines have faced due to missing linkages between local level initiatives and national level policies that have prevented successful sustainability experiments to reach institutional up-scaling. Then, the Chilean case suggests that both governments and policy entrepreneurs will need to play indispensable roles in transition processes, as are likely to involve major socio-technical changes and power struggles that will require governmental commitment and entrepreneurial action. Moreover, recognizing the role of agency in transition processes brings up the need for experts in the field to come up with plausible recommendations, especially for governments, to start triggering and steering transitions in developing economies.

Putting aside for a moment all the pending issues that are to be improved, the transition has involved progress in multiple fronts, but especially in terms of the shift towards the use of cleaner energy technologies, and the approach for doing energy policy in Chile. All experts expect the electricity transition in Chile to continue advancing in incoming years. In the next chapter I review the main challenges that the transition faces for moving forward and give a series of policy recommendations for enabling the shift towards renewables to continue happening.

CHAPTER 6. CHALLENGES AHEAD AND POLICY RECOMMENDATIONS

6.1. Introduction

This chapter addresses the last research question that motivated this dissertation: *What challenges are ahead for the Chilean energy transition? Based on obtained findings and theoretical analysis, what recommendations might be useful for future energy policy-making in Chile?*

The chapter begins introducing the methods used for identifying the different challenges that threat further growth of the renewable energy sector in Chile. After that, I present a list of policy recommendations for overcoming those challenges and moving the transition forward. I end the chapter with a brief set of conclusions from the analysis.

6.2. Challenges ahead for the Chilean transition

Stakeholders in the energy sector generally agree in the perception that the renewable energy sector in Chile will continue to grow. Nonetheless, they acknowledge the need for sorting out a series of challenges that might prevent or slow down that growth. Informed by the analysis developed in previous chapters and gathering suggestions explicitly pointed out by interviewees I have identified the following challenges that the Chilean transition faces for moving forward:

New electricity generation targets have not been formalized by law, and lack a strategy through which they are to be achieved. Many interviewees pointed out the fact that energy targets proposed in the *Energy 2050* document have not been formalized by law, which threatens the continuity of the transition over time, as proposed goals might be easily changed by incoming governments if they are not established in a formal legislation document. Moreover, the *Energy 2050* policy so far does not have a roadmap of policy instruments and regulations that define a pathway for accomplishing the proposed goals. Importantly, the formalization of proposed targets and the definition of a set of policy measures to be implemented for moving the transition to renewables forward while discontinuing the use of fossil fuel energy sources is likely to raise important opposition from incumbent companies, and then would require great political effort.

Lack of adequate long-term planning in the electricity sector. The electricity sector governance in Chile incorporates much more planning concepts that it used to by 2004. The implementation of renewable energy targets was among the first steps towards the incorporation of steering mechanisms in the sector, though the most important one came as part of the transmission law passed just in mid 2016, which incorporates a yearly assessment of the entire transmission system and is expected to offer suggestions for future investment in both the generation and transmission sectors. This does not guarantee though, that such suggestions are going to be followed or materialized by investors. Despite the relevance of the planning component in the transmission system, some interviewees suggested the need for a systemic view of the sector that allows for management and optimization of its general operation. Leaving final decisions in hands of private investors has so far failed to yield the most convenient outcomes for the country, and then an overall perspective is needed in order to steer the system in a desired direction.

Market regulation and restructuration policies have not been passed in a timely manner and this pattern is likely to continue. Indeed, policies and regulatory instruments implemented so far have often lagged considerably behind their need. Technical regulations for ancillary services took around 7 years to be ready (for no specific reason). The implementation of the regulatory framework for a market for ancillary services was announced last year, as part of the transmission law, but they are still pendant. The transmission law was also passed considerable time after curtailment problems have been occurring. This gap prejudices the sector's development reducing efficiency and delaying investment. If the NCRE sector continues to develop as it is expected to occur, further changes will be needed. Moreover, many of them are likely to be of controversial nature, which would extend even more the timespan needed to politically approve them. As an example of this, many developers think that a major expansion of the renewable energy sector in Chile would require a deep restructuration of the marginal cost system that Chile utilizes for remunerating generators who trade electricity through the wholesale market.

Social conflicts are likely to increasingly threaten NCRE projects in the future. The infrastructure sector in Chile and in Latin America in general has been facing important conflicts of social and environmental nature in the last decades and this trend is likely to continue. In Chile, NCRE companies that have adapted their business development models reported that they have been generally able to move forward with their projects. But despite the greater acceptance level that they have enjoyed so far (compared to conventional electricity generation projects), the proliferation of NCRE projects is likely to further increase the opposition of local communities. This underscores the need for developing projects in a more inclusive and participatory way, integrating communities to both decision-making stages as well as to project development work, which has proven to raise less rejection from local communities while maximizing synergies generated from join work. The private sector has fervently asked the government for guidance in this respect, but defining limits and obligations for both involved parties is still pendant. To this is added the problem of unscrupulous people that in recent years have tried to take advantage from the tense situation, encouraging communities to ask for monetary compensation in exchange for lower opposition.

Lack of a well defined land-use policy. In direct relation to social conflicts, especially in indigenous territories in the South of Chile, is the lack of land-use policy in the country (in Spanish called *ordenamiento territorial*). Currently, Chile does not have a land management policy that regulates land-use for developing projects in the electricity sector, an issue that has been criticized by some researchers and advocacy organizations (Cordero et. al, 2015). As a result the decision of whether to install a power plant in a certain place relies on private sector hands and only depends on acquiring the necessary technical and environmental permits. The new transmission law incorporates a first attempt for improving this, by establishing the definition of certain zones where transmission lines will be allowed to be built. The government has started to address this issue but so far it remains as an open debate.

Energy demand expectations for the future are not perceived by investors as good as they were, so there is a need for expanding the market for renewables. Indeed, developers generally manifested uncertainty with respect to future energy demand trends for Chile. This, mostly due to the strong dependence on copper that the country has, as copper prices and investment in the mining sector have decreased in recent years. A contraction of the mining sector necessarily implies the same in the energy and electricity sectors, which is likely to constraint energy demand unless new market options are open.

Lack of adequate distributed generation regulation. In line with the above, Chile also lacks a regulation that properly regulates distributed generation. In 2012, Chile passed a net-metering law that allows consumers that generate their own electricity to sell their surplus to the grid, though the payment rate schemes have been criticized for not providing enough incentives for building residential generation arrangements (distribution companies currently remunerate electricity to home-generators at approximately 50% the price they charge for it, which makes payback periods as long as 20 years). The lack of a proper distributed generation law is likely to limit the market for NCRE generation, as well as available options for decentralizing and democratizing the electricity sector. Currently, the Chilean government committed through a loan obtained from the Inter-American Development Bank by late 2016, to the drafting of a preliminary bill regulating electricity distribution, relating to: (a) distribution planning; (b) distributed power generation; (c) service quality; (d) remuneration of the network and its rate scheme; and (e) the industry's business model. This is committed to be ready by 2017.

Renewable energy technologies have limited access to financing options due to the difficulties for getting power purchase agreements. This corresponded to one of the main hurdles that the NCRE sector faced when the transition was starting, but the situation improved when national banks started to observe the experiences of successful projects and learn about the new technologies operated. This situation further improved when the public tender regulation was modified giving NCRE generation companies access to the market of regulated consumers. Although, more recently the situation has become complicated again, as prices bid by renewable energy generators have increasingly fallen causing skepticism in the financial sector, which couple with the volatility of energy prices in Chile, social conflicts and the uncertainty of energy demand still entail financial risks that Chilean banks are reluctant to incur.

Lack of the necessary workforce for supporting the renewable energy sector's development. The transition in Chile has been in great part carried out by foreign engineering and construction companies, mostly because they generally charge less and have more experience than national firms. Even from the site visits and interviews it was possible to observe an important number of foreign workers in the sector at all levels. Indeed, many international reports have noted that Chile exhibits a lack of skilled labor force, at both white and blue collar levels, that is able to support the further development of the sector (US ITA 2013; MaRS, 2015). Currently, there are some ongoing initiatives of training and educational programs, especially at the technical level, developed by the government and the German Society for International Cooperation (GIZ), but this is still too modest for satisfying the raising demand.

Lack of substantial support for technological development. This issue has been repeatedly noted throughout the dissertation and refers to the lack of technological development that has characterized the Chilean transition, as well as to the limited support on part of the state for the development of an industry associated to the renewables' sector. As mentioned before, the Chilean government is starting to put effort in developing a local solar industry (starting with the adaptation of solar PV technologies), with the hope that eventually Chile becomes an exporter of solar energy, though support is still very limited.

6.3. Policy recommendations

I offer a list of policy recommendations that the Chilean government might want to implement for addressing the challenges identified in the previous section. For elaborating the list I start from the assumption that Chile wants to further advance the development of renewables, as expressed in the *Energy 2050* policy document, as well as in other climate change-related agreements. Starting from that premise, and considering the Chilean socio-economic and political context, these are the main areas of action that I recommend the Chilean government to acknowledge and address:

Formalize renewable energy targets and work in designing a roadmap for achieving them. Establishing renewable energy targets by law would consolidate them over time, preventing their rollback on the part of possible incoming governments with opposite ideologies. In addition to that, there is the need for designing a strategy for achieving renewable energy targets. As experience in Chile and the world has shown, the establishment of incremental targets needs to be complemented with supporting policy instruments, as well as technical regulations and institutions that provide the needed regulatory and institutional framework for achieving purposed goals. Importantly, the design and implementation of such policy mix is likely to involve important power struggles and resistance. For example, one aspect that interviewees suggested was the need for stopping the construction of coal power plants and start scheduling the decommission of existing ones, which would most likely rise important incumbent opposition.

Adopt an approach to energy policy-making that allows for assessing the electricity system's development with a systemic perspective and for steering it towards desired objectives. During the last decade, the country has faced the hurdles of relying almost only on market forces for the management of the electricity sector. Experience has taught Chile that liberalization models bring certain benefits but overall, they do not necessarily steer electricity systems towards socially desirable outcomes. This suggests the need for adopting an approach to energy policy-making that, beyond the establishment of certain targets, incorporates planning components that allow for acquiring a systemic perspective of the electricity system and inform decisions that enable its steering towards (democratically) defined objectives.

Perform periodic assessments of the electricity system that allows for anticipating its needs and implementing necessary reforms in a timely manner. So far, the Chilean state has had mostly a reactionary approach, though in order to smooth the system's operation it is necessary to adopt a much more anticipatory attitude for the development of complementary regulations and technical requirements that avoids downtimes and bottlenecks. The transmission law represents an important planning step that now has established the development of periodic assessments of the transmission system, adopting an approach that has yielded positive results in developed countries (e.g. California and the UK). It is important though, that the knowledge gained from such assessments starts informing future investment decisions and regulations that will need to be made/implemented in advance, anticipating the future requirements of the system.

Continue the implementation and improvement of strategies for more participatory and democratic policy-making and business development in the energy sector. Advancements in this regard have been important and unprecedented, but further improvement is necessary from a democratic and economic perspective. Indeed, experience in the sector suggests that projects that are developed in a more inclusive and democratic way raise less rejection from communities, and conflicts become more manageable and workable, ultimately enabling projects to materialize. Particularly for addressing issues related to business development in the sector, I would recommend defining clear rights and duties for the different parties involved as well as establishing the conditions for the existence of a proper deliberation context through the regulation of deliberation processes.

Develop a well-defined land-use policy for guiding infrastructure development in the electricity sector. As advocacy groups and some researchers have suggested, this is necessary for ensuring a more democratic and equitable use of the land in Chile. Moreover, the establishment of a land-use policy is also likely to diminish social and environmental conflicts (if the population perceives the policy and the process through which it is developed as equitable and democratic).

Continue working towards the development of regional integration with neighboring countries in the area, in order to expand electricity markets and increase energy security and system stability. Beyond the divergent opinions around the idea of exporting electricity (mostly due to environmental concerns that this might entail), a regional interconnection would certainly bring more security and stability to the system, as it has been the case in European countries and in regional interconnections in the US. This would increase the expansion possibilities of a system that eventually relies heavily on intermittent technologies, and its hydro resources are heavily threatened by climate change.

Develop a distributed generation regulation that allows for the decentralizing the electricity system contributing to advancing energy democratization, while encouraging the use of renewable energy sources. Chile is currently working on a distributed generation law. On the one hand, it is important that such legislation is ready in a reasonable amount of time, and afterwards that the related technical regulations are also developed in a timely manner. On the other hand, it is necessary that such legislation is designed in a proper way so as to provide enough incentives for encouraging home-based and small-scale generation in general, as well as to define the necessary apparatus for the design of a secure, and robust distributional network.

Offer support to the private sector for getting access to financing sources. Getting access to financing from local banks has been one of the major hurdles preventing the development of NCRE projects in Chile. The situation has improved with the access to Power Purchase Agreements (PPAs), especially after the modification on the public tender legislation, but still concerns on part of financing entities come back and forth. The government might offer further support for dissipating doubts and risks that keep concerning financing entities. Another option for expanding the market of NCRE generation technologies is to get access to *free clients* (non-regulated consumers), which consume about 45% of the electricity generated in the country. So far, this has not happened mostly due to inexperience and path-dependency reasons, as non-regulated consumers have traditionally been used to get electricity contracts in terms of constant power amounts, as opposed to energy blocks (the exact same issue that was modified in public tenders). The government might offer help by continue to intercede on behalf of the NCRE sector, and/or providing the necessary guidance and support that would encourage the so-called *free clients* to change their traditional contracting approaches.

Implement education policies that train the necessary workforce for supporting expected electricity sector's development. It is important that the Chilean state anticipates the need of renewables' energy market development, and supports existent (and develops new) education and training programs for satisfying those needs, especially for not constraining the sector's development due to the lack of skilled labor force. Moreover, if the sector continues to grow it might represent an important job source that the country should take advantage of.

Support more aggressively technological development in the energy sector. So far, the transition has been developed based on imports of technology and knowledge. Chile, as a transition economy still dependent on commodities' exports needs to start thinking on a more aggressive strategy for pursuing development. The option that the government has chosen is to support the development of a local solar industry, though other options are available. On the one hand, one the option is supporting other energy niches that might offer comparative advantages to Chile, e.g. the development of marine energy technologies or solar concentrator technologies. On the other hand, there is the alternative of choosing other instances of the long value chain that energy services comprise, for example, related to developing specialized, exportable skills in designing system operating software for power networks with high rates of renewables penetration, or in transmission system modeling or (in the future) in energy storage management services. In any case, whatever ends up being the chosen strategy, more support will be needed to significantly boost the development of a local industrial sector, which will likely comprise monetary incentives and regulation policies capable of creating a proper environment that offers protection, nurturing and empowerment.

CHAPTER 7. CONCLUSIONS

7.1. Introduction

This final chapter presents a summary of the main findings obtained from the analysis of the Chilean transitions to renewables. I revisit each one of the research questions summarizing the answers that the analysis developed in the previous chapters offers. Findings are both of theoretical and political character. In addition to that, I explicitly identify policy lessons that the research on the Chilean case suggests for steering and managing transitions, especially in developing countries' contexts. I also review the relevance and implications of the presented study, and end the chapter discussing its limitations and future research veins on the topic.

7.2. Discussion of main findings

This section discusses the main findings of the study on the Chilean transition, which are organized around each of the research questions that motivated the dissertation.

7.2.1. Overall research question

Why has a transition process towards the use of renewable energy unfolded in Chile during the last decade? What does the empirical evidence from the Chilean case tell about how and why transition processes come about?

The Chilean transition process is likely to have resulted as an outcome of a multiplicity of factors that got aligned, allowing socio-technical change to start taking place. Such factors include: the existence of a crisis that opened up a window of opportunity for socio-technical change, the availability of high-quality renewable energy resources, lack of fossil fuel resources, high energy prices and promising energy demand expectations, the push that social organizations (mainly environmental NGOs and NCRE industry associations) started to exert to encourage renewables' deployment, the opposition faced by conventional energy projects on part of local communities across the country, the increasing availability of financing, the appropriate modifications of the electricity sector's regulatory framework, the implementations of supporting policy programs and the long-term commitments sustained by the government for continuing fostering renewables' deployment, the increasing improvement on renewable energy technologies and the continuous drop in technology costs, the stable macroeconomic situation of the country and the existence of an environment for business development. Many of the aforementioned factors do not offer much room for agency and then cannot be reproduced, but some fundamental ones suggest the possibility of emulating them for triggering and steering transitions in other sectors/countries with similar contexts. Sub-questions 1 and 2 (corresponding to Chapters 3 and 4 respectively) look at two of those key aspects making apparent the key role that policy entrepreneurs, mainly from social organizations, played in triggering and lobbying for enabling the transition to happen, as well as unraveling the crucial functions performed by the Chilean government for both enabling a market for renewables to start emerging, while switching the energy policy approach of the country towards one that now considers steering and planning components.

A particular feature of the Chilean transition is that so far it has only involved the adoption of new technologies developed mostly in developed countries. This has implied that the transition process has been much shorter than what it has taken in developed nations where transition processes have comprised technological innovation, as it is the case of the development of solar PV technologies in Germany. Currently, Chile is putting efforts in developing a local solar industry, aiming to start with the adaptation of imported technologies. Though results remain to be seen, the strategy that Chile is following might represent a promising transitioning approach for developing countries, offering a transitional strategy for pushing forward local development through the advancement of technology or of associated knowledge or service industries, in this case by exploiting a comparative advantage in the generation of clean energy.

From a theoretical perspective, the Chilean case is useful for testing the adequacy of sustainability transitions theories for understanding the dynamics of transitions, particularly for those occurring in developing countries contexts. The Multi-Level Perspective (MLP) approach proves to offer a useful model for making sense of the changes and interactions that characterize a transition process from an overall viewpoint, though the most recent version of the model does not fully account for all the interactions that have taken place in the Chilean case. In a complementary way, and adopting a much closer look on the interactions between actors, technologies and institutions, the typology of transition pathways proposed by Geels et. al (2016) is also useful for characterizing the Chilean transition. According to this model, the Chilean story started following a substitution pathway that followed a fit-and-conform pattern, that is, expecting renewables to be able to compete with others in the market, then, a shift towards a stretch-and-transform pattern started to take place, which is characterized by the adjustment of rules and institutions to suit the incoming innovations. More recently, the Chilean electricity transition started to exhibit characteristics of a transformation pathway, as incumbents have started to enter the renewables' market persuaded by the business opportunities that the sector is offering.

Though both models, the MLP and the typology of transition pathways, provide a useful language for analyzing transition dynamics, neither one of them fully accounts for the interactions happening in the Chilean case. This suggests that available theories might be better understood as analytical tools that may provide a language and offer a flexible framework for the understanding of transitions' interactions, instead of being conceived as rigid models that attempt to account for all possible cases. Indeed, the complexity of socio-technical transition processes suggests that only flexible, fluid frameworks would be able to accommodate for the multiple variations that transitions in contrasting contexts from developed and developing countries are likely to incur.

7.2.2. Specific research sub-questions

<u>Sub-question 1:</u> *What has been the role of social movements and organizations in opening up windows of opportunity for socio-technical change towards the use of renewable energy in Chile and why did they decide to engage in the transition process in the ways they have?*

The Chilean transition to renewables is marked by a social character. Social organizations, social movements and advocacy coalitions have played crucial roles, engaging in the transition for different motives. Social organizations, acting as policy entrepreneurs, identified the window of opportunity that the energy crises had opened up, and actively pushed for putting on the policy agenda the option that renewables had to offer. They introduced ideas, pushing and lobbying for them, and acted as builders of advocacy coalitions. The formation of advocacy coalitions, was essential for providing the necessary support for overcoming opposition and thus enabling the implementation of controversial policy change. This coupled with the opposition that local communities and massive social movements raised against conventional energy technologies, preventing the development of projects and contributing to rising energy prices and highlighting the need for alternative energy sources.

All the involved actors had different motivations for supporting the cause of renewables — environmental NGOs and activists did it mostly for environmental reasons, though equity reasons were also a crucial part of their claims, NCRE industry associations acted mostly with a business interest, the government eventually joined the coalition firstly motivated by energy security and economic efficiency reasons, though more lately also incorporating sustainability as a central objective, and local communities and the civil society in general had a multiplicity of reasons with environmental, governance and equity issues at the core—, though they put aside their motivational differences and joined forces around the common objective of pushing the NCRE energy sector's development. Interestingly, the international community is recognized to have played an important supporting role by setting and example and a world-wide agenda but also by offering direct support to local policy entrepreneurs, as it was the case in the Chilean most emblematic cases of environmental conflict.

In recent years, in part as a result of the continued rejection from local communities and the civil society in general to conventional energy projects, but also after having witnessed the success of NCRE initiatives and their wide degree of acceptance, incumbent firms have started to increasingly invest in the renewables' sector, particularly those that were acquired by international companies.

While this has favored the increasing consolidation of the transition, it comes with the risk that incumbents may appropriate it, which may cause that it gets diluted over time, as energy issues get replaced in the political agenda by other more urgent concerns and the advocacy coalition loses forces and adepts. The hope to stick in the transition's path is the integration of renewables as a core pillar of the new long-term energy policy that the Chilean government launched in 2015, though the proposed targets of achieving 50% and 70% of the national energy mix from renewables by 2035 and 2050 respectively, would need to get established by law for avoiding the risk of getting replaced by incoming governments.

From a theoretical perspective, the Chilean case reaffirms the need for paying special attention to the politics of transition processes —including power relationships and different forms of regime resistance— and how they may shape transitions' outcomes. The Chilean transition offers an example of a case where regime resistance is being overcome, leading to the destabilization and decline of the old fossil-fuel dependent regime. In the Chilean transition, achieving socio-technical change in the existent energy policy regime was possible thanks in great part to the role played by policy entrepreneurs and advocacy coalitions. This highlights the need for studying how policy entrepreneurs might trigger and foster transition processes in developing countries, especially because their role might be particularly relevant in contexts where sustainability ideas and green coalitions are not consolidated and need to be developed from early stages.

One important side-product of the Chilean transition and its social character has been the progress made towards the implementation of a more participatory and legitimate way both for doing business and for policy-making in the energy sector. Indeed, the high degree of involvement that policy entrepreneurs, activists and the civil society in general have had in the political process of change, have forced the public and private sector to seek for participation measures as the way to go for obtaining acceptance and legitimacy. Despite the flaws of the deliberative processes implemented so far in both the public and private sectors, the shift towards starting to consider more democratic decision-making approaches represents a pioneering and hopeful step towards democratic policy-making in Chile. With all, experts have noted the imperative need for addressing participatory instances carefully, not risking their discredit, as they may represent an invaluable opportunity towards the design of more just, legitimate and sustainable policies. Theoretically, this further remarks the necessity of advancing deliberation studies and methodologies for policy-making practitioners, but also adds the need for developing them oriented to the private sector. Indeed, the experience of the NCRE sector in Chile seems to indicate a valuable opportunity for advancing transitions from a bottom-up perspective, with companies integrating local communities to projects' development that seek more environmentally-friendly and democratic goals —which seem to enjoy more social acceptance and cooperation from local communities—, while creating synergies and opportunities with them along the way.

<u>Sub-question 2:</u> *What has been the role of the Chilean government in the energy transition taking place in Chile and why has it acted in such ways? In particular, how have regulations modified the structure of the electricity market and in which ways this has affected the transition?*

The study of the Chilean transition has made apparent the crucial role that the Chilean government has played in the process. Indeed, evidence shows that the Chilean government has contributed to opening a new market for NCRE generation technologies in the country by creating an energy policy strategy, implementing market regulations and developing the necessary institutional capacity for materializing both policies and regulations. Indeed, the functions that the government has performed have contributed to key aspects of transitions' development identified by sustainability transition management approaches, namely institutional change, market formation, new entrants, and advocacy coalitions.

Overall, the Chilean case also argues for the need for regulation and planning in the electricity sector in light of the necessity for steering it towards desirable societal directions, as it is the urgency for cleaner electricity generation. Consistent with other countries' experiences, the Chilean case demonstrates empirically that complete liberalization does not respond adequately to the sustainability challenges of our time, and then there is a necessity for incorporating a certain degree of policy regulation and planning into energy sectoral policy, particularly for addressing price barriers and transmission needs. This argues for the need of finding a balance that allows taking advantage of the benefits that electricity liberalization yields, while complementing its shortcomings with appropriate policies that allow for the steering of the system.

Despite all efforts, the results of the transition are still moderate. On the government side, while implemented policies and actions have been relevant and valuable, adopting a much more aggressive and anticipatory approach (as opposed to a moderate and reactionary one) might yield more substantial results for fostering renewables' deployment. Future prospects for the transition's further development are optimistic, though multiple challenges remain. Amongst those that require governmental action are the need for developing a market for ancillary services, modifying the marginal cost system, dealing appropriately with social conflicts, and fostering technological development in the sector.

<u>Sub-question 3:</u> *What challenges are ahead for the Chilean energy transition? Based on obtained findings and theoretical analyzes, what recommendations might be useful for future energy policy-making in Chile?*

Even considering the valuable progress towards the use of renewables and the positive expectations of experts and stakeholders with respect to the further development of the renewable energy sector in Chile, the transition still faces several challenges. Among the most important ones are:

- New electricity generation targets have not been formalized by law, and lack a strategy through which they are to be achieved
- Lack of adequate long-term planning in the electricity sector.
- Market regulation and restructuration policies have not been passed in a timely manner and this pattern is likely to continue.
- Social conflicts are likely to increasingly threaten NCRE projects in the future.

- Lack of a well defined land-use policy.
- Energy demand expectations for the future are not perceived by investors as good as they were, so there is a need for expanding the market for renewables.
- Lack of adequate distributed generation regulation.
- Renewable energy technologies have limited access to financing options due to the difficulties for getting power purchase agreements.
- Lack of the necessary workforce for supporting the renewable energy sector's development.
- Lack of substantial support for technological development.

For addressing the aforementioned challenges I suggest the following list of policy recommendations:

- Formalize renewable energy targets and work in designing a roadmap for achieving them.
- Adopt an approach to energy policy-making that allows for assessing the electricity system's development with a systemic perspective and for steering it towards desired objectives.
- Perform periodic assessments of the electricity system that allows for anticipating its needs and implementing necessary reforms in a timely manner.
- Continue the implementation and improvement of strategies for more participatory and democratic policy-making and business development in the energy sector.
- Develop a well-defined land-use policy for guiding infrastructure development in the electricity sector.
- Continue working towards the development of regional integration with neighboring countries in the area, in order to expand electricity markets and increase energy security and system stability.
- Develop a distributed generation regulation that allows for the decentralizing the electricity system contributing to advancing energy democratization, while encouraging the use of renewable energy sources.
- Offer support to the private sector for getting access to financing sources.

- Implement education policies that train the necessary workforce for supporting expected electricity sector's development.
- Support more aggressively technological development in the energy sector.

Overall, the transition to renewables that Chile is navigating represents an opportunity for the country to continue to move towards the status of a developed nation, while increasingly embracing mainstream sustainable practices. Although, taking the most advantage of this moment is also a challenge that the Chilean leadership will need to undertake. Chile's richness in terms of renewable energy resources might represent an open door for starting to depart from the traditional resource-based economic pattern that has characterized the country so far towards a more knowledge and service-based economy.

7.3. Relevance and implications

First and foremost, the presented study corresponds to the first attempt for documenting and analyzing the transition process towards the use of renewable energy that started to develop in Chile in the last decade. The study generated both a theoretical and a policy contribution that offer insights for the understanding and management of transitions, especially those happening in developing countries.

7.3.1. Theoretical contribution

On the theoretical side, the study of the Chilean transition contributes to the analysis of how sustainability transitions take place, offering a developing country-perspective. The Chilean case serves to test the MLP model and the typology of transition pathways proposed by Geels et al. (2016), finding both of them useful at different levels of analysis but only to a limited extent, as none of them are able to completely account for the dynamics taking place in the Chilean transition. Though the Chilean case offers complementary considerations for advancing both models, the analysis suggests that instead of being understood as rigid models/typologies that account for all possible interaction types, available theories might be more useful if conceived as flexible frameworks or collections of possible future pathways gathered from experience, that offer a useful language for the study of transition dynamics.

The study of the Chilean transition reinforces the need for paying particular attention to the politics of transition processes, and the power dynamics that they embed. The Chilean case particularly highlights the relevant role that policy entrepreneurs and advocacy coalitions play in transitions that involve socio-technical change. Indeed, in the Chilean case entrepreneurs prove to be key actors of the process, being the ones that took advantage of the window of opportunity that the energy crisis had opened up, introducing ideas on the political agenda and lobbying for advancing them, and organizing advocacy coalitions for materializing socio-technical change. The Chilean transition then suggests that the role of policy entrepreneurs might be particularly important in developing countries that lack consolidated green coalitions (such as those that have existed for long in Western European countries).

In addition to the above, the Chilean case offers an example of the role that governments might take as leaders of transition processes. Even though the Chilean transition does not correspond to a transition management case (that implemented some of the strategies that sustainability transitions literature proposes), the Chilean government did play a key enabler role that allowed socio-technical change to take place. In line with transitions literature, the Chilean case exhibits the four elements that the TIS research identifies as needed for a niche of new technologies to start developing —institutional change, market formation, new entrants and advocacy coalitions— with the government contributing to each one of them.

The two aforementioned contributions speak about the potential agency that policy entrepreneurs and governments may exploit in transition processes, but at the same time are likely to be necessary pieces on them. The Chilean case suggests that, given the depth of (socio-technical) changes that transitions necessarily involve —involving the overthrow locked-in regimes and materializing deep institutional and cultural changes—the role that governments are to play is a necessary piece that cannot be missed. In the cases of proactive governments, the role that entrepreneurs may play might be less crucial for unleashing such changes such as in cases like the

Netherlands' transition management initiative (see Kemp and Loorbach, 2003), though it might also be that entrepreneurs come from inside the government. In contexts with less interested governments in unleashing/fostering transitions initiatives, the push that entrepreneurs might exert is likely to be key for triggering transitions, for introducing ideas and for exerting pressure for government commitment. Also, depending on the magnitude of the power struggles that characterize transition processes, entrepreneurs are likely to play an irreplaceable role as crucial coalition builders and idea promoters.

The study developed in this dissertation also speaks about the relevance of the sustainability transitions research field and its relationship with other disciplines. The analyzed Chilean case underscores the contribution of this emerging field of study as a connecting arena between social sciences, environmental and technology-related disciplines, where the knowledge developed in different fields is used for the analysis of the dynamics of transition processes. This at the same time suggests that the main potential contribution of the transitions field might not be to focus on the development of new explanatory theories, but rather to take advantage of advances in political science, policy analysis, economics and other fields, combining them for the analysis of transitions problems, given their inherently multidisciplinary nature. Besides that, and thanks to its policy-oriented nature, the transitions field has the additional value of putting especial effort into elaborating policy recommendations for transitions' steering from the gained understanding of transition phenomena, which is of especial relevance from a policy-practitioners' perspective.

7.3.2. Policy contribution

On the policy side, this dissertation offers an exhaustive case study of the transition to renewables that started to take place in Chile, one of the leading countries in Latin America. While acknowledging the context-dependency of transitions, it is possible to identify a collection of lessons and good practices from the Chilean government's experience that might shed light and be reproduced for the steering of transitions in other developing countries under similar circumstances:

Electricity markets not yielding socially desirable outcomes might require restructuration for steering their transition to renewables. The Chilean transition provides another example of how liberalized electricity markets, despite their ability of improving efficiency and facilitate investment and access to services, have not been able to yield the socially desirable objectives of energy security, environmental sustainability, and sometimes even economic-efficiency. Given global need for embarking in an energy transition to renewables —and in the case of Chile for augmenting the country's energy security and cost-efficiency—, many countries have found necessary to intervene their liberalized electricity sectors in order to steer them in preferable directions. Experience has shown that introducing regulatory policies and planning measures seems to be necessary for fostering a transition towards the use of clean energy technologies. On the one hand, there is a need for opening up a market for renewables that in the beginning will need a protected development space that offers shielding, nurturing and empowering properties. On the other hand, there is the need for implementing planning measures, particularly in the transmission sector, that add the option of managing the system's operation in a systemic way and allows for planning ahead of congestion events. The Chilean case adds up to the experiences of the UK and the states of California and Texas, which show how pro-liberalization countries have been forced to implement regulatory reforms and planning measures for steering their respective electricity sectors.

Developing countries might embark in transitions following a transitional approach by first adopting clean energy technologies developed elsewhere and then transitioning towards adaptation and local technology-associated development. The Chilean case corresponds to an example where a sustainability transition towards the use of renewables started by importing (mature) clean energy technologies from the developed world. Now that the transition to renewables is starting to consolidate in the country —with a formative stage that developed in a timespan much shorter than the case of developed countries cases that involved technological development— Chile has started to perceive the transition as an opportunity to pursue development. Indeed, Chile is currently concentrating efforts in developing a local solar industry, as the Atacama Desert is perceived to have comparative advantages for electricity generation, which might offer the opportunity to expand the market by exporting energy to neighboring countries in the future. Strategies for now are focused on the adaptation of solar technologies to the particular characteristics of the Atacama Desert, but there are also opportunities in associated services and knowledge industries. The approach that Chile is following might potentially represent an interesting transitioning model that might offer the opportunity of both implementing sustainability transitions in a much faster way and using them for boosting the development of local economic sectors.

Up-scaling transitions involve political processes and power struggles that requires the active involvement of policy entrepreneurs and advocacy coalitions for changing embedded socio-technical regimes. Indeed, the political aspect of transition processes has been emphasized by many authors in the literature, though the Chilean case highlights the role that policy entrepreneurs in particular need to play. While transitions researchers have noted the importance of advocacy coalitions in such processes, they underestimate the role that policy entrepreneurs, in contexts characterized by the absence of long-standing green coalitions such as those existent in European countries, are to play as builders of massive advocacy groups. The study of the Chilean transition has shown how policy entrepreneurs —environmental NGOs and NCRE industry associations in the Chilean case— were able to put issues on the political agenda, and mobilize political support for translating them into policy regime change.

The social nature of transition processes suggests that participation and deliberation practices are likely to increase the legitimacy of policy-making and business development processes required for implementing socio-technical change. The Chilean transition was marked by a social character from the beginning. Beyond stakeholders of the electricity sector, social organizations, local communities and the civil society were part of the process (with different degrees of involvement though). This forced the government and the private sector to start shifting towards more participatory ways of doing energy policy and developing businesses. This has allowed projects to enjoy more legitimacy and acceptance among the public in general, many times even representing the only option for moving forward. Indeed, the NCRE sector in Chile perceives as key for the development of the sector their strategy of adopting a much more inclusive approach towards project development, which was coupled with a much more open attitude of communities towards clean energy technologies compared to conventional projects. The Chilean experience then suggests that transitions to sustainability might be much more likely to enjoy acceptance and legitimacy, and even to occur, if they are developed through more inclusive and democratic processes.

All the aforementioned insights may also be potentially helpful for transitions occurring in other sectors, both in Chile and other countries.

7.4. Limitations and future research veins

Despite the novelty of the case and its relevant theoretical and policy contributions, certain limitations of the research study as well as some of its findings offer multiple veins for future research.

A first limitation of this research relates to data availability. The study was developed mainly using qualitative techniques, and conclusions were achieved mostly by triangulating information from the document review with the different opinions of interviewees, and contrasting that with the evidence from quantitative data when possible. Fortunately, most of the time findings achieved through the aforementioned methods yielded coherent results. Due to data availability reasons, it was not possible for example, to monetary quantify the impacts of the transition, neither to track some of its dynamics (as in Chile this kind of data is collected and managed by a private sector entity). Complementing the study with an analysis of the relevant money trends would allow for exploring in a more precise way how investment in the electricity sector has shifted between different technologies across the years, what has been the origin of such investment, as well as analyzing the gap between the generation and transmission sectors' expansion. The development of engineering-economic studies that compare the costs, environmental impacts and economic implications related to NCRE projects with conventional energy ones that have been developed (or proposed to be developed) in the country would be another research vein to explore.

Another important limitation of the study relates to the level of granularity that was used for performing the analysis. The study had mostly an overall character, looking at Chilean transition dynamics from a general perspective, though it also involved adopting a much closer perspective for analyzing interactions between actors, institutions and technologies. It would be interesting to complement it by exploring in depth at how involved policy mixes —that is, arrangements of multiple policy goals and instruments— have varied across the years, impacting transition outcomes in complementary and/or contradictory ways. In a similar way, it would also be useful to look deeper into the policy process of change (from a policy analysis perspective) to explore how narratives of change have been able to overcome narratives of continuity, enabling socio-technical change to happen.

An additional constraint of this research relates to the limited analysis of international influences on the transition. Indeed, as it was mentioned throughout the study, multiple foreign technologies, project developers and NGOs had a relevant effect on the transition process, influencing it through the transference of ideas and technologies. Though this aspect was addressed to the extent possible, exploring such influences in more depth and the ways in which they unfold might reveal interesting ties and new steering possibilities.

In relation to the above, another research vein that might be worth exploring in more depth relates to the role that international development agencies and multilateral organizations played in the Chilean transition. Though very relevant, their role in allowing the opening of a market for renewables in Chile was not a focus of this dissertation, but it is certainly an aspect that might unravel the potential that such institutions may have for encouraging and enabling transitions in developing nations.

In addition to the above, the recognition of the room for agency that transition processes might offer suggests the that there is a need for experts in the field to come up with plausible recommendations, especially for governments, for starting to trigger and steer transitions towards more sustainable practices across all policy/economic domains. The Chilean case in particular seems to suggest the option of starting transitioning processes in developing countries with the adoption of mature new technologies and from that transitioning to technology adaptation and later to local technological development, or to the specialization in some associated knowledge or service industry of the sector, depending on the comparative advantages of different countries. This is just starting to take place in Chile and results remain to be seen, so further studies in this regard would be required. Transition researchers might contribute by studying the dynamics of these kinds of processes and offering policy recommendations for carrying them on. The study of the Chilean transition also suggests the research vein of exploring more in depth the role that policy entrepreneurs play in transition processes, especially in developing countries' context, in order to identify under what conditions they are most likely to able to push sustainability policies forward.

Last but not least, the study has made apparent the need for further advancing deliberation studies and participatory approaches, especially for coming up with methodologies that are adequate for facilitating transition processes for policy-making and business development.

APPENDIX A. LIST OF INTERVIEWEES' POSITIONS

Government officials: Ministry of Energy and National Energy Commission.

1. Ex-minister of Energy (was also the First Minister of Energy in Chile when it was created in 2010), current CEO of the National Petroleum Company (in Spanish *Empresa Nacional del Petróleo*, ENAP).

2. Director of the Division for Renewable Energy, Ministry of Energy.

3. Director of the Division for Forecasting and Energy Policy, Ministry of Energy.

4. Director of the Unit for Participation, Ministry of Energy.

5. Director of the Division for Sustainable Development, Ministry of Energy.

6. Director or the National Energy Commission (in Spanish *Comisión Nacional de Energía*, CNE).

Chilean Economic Development Agency (in Spanish *Corporación de Fomento de la Producción*, CORFO), Ministry of Economy.

7. Coordinator, CORFO International R&D Energy Centers of Excellence. Before: he had worked evaluating renewable energy innovation projects at CORFO, and as technical management and project coordinator at the regulation institution CDEC-SING (independent grid operator for the SING).

8. Director, CORFO Investment and Financing Department, Ministry of Economy.

9. Director, National Center for Innovation and Promotion of Renewable Energy (in Spanish *Centro de Innovación y Fomento de Energías Renovables*, CIFES).

National financial sector executives

10. Head of Project Finance at Banco BICE.

11. Deputy General Manager of Corporate Banking responsible for energy sector at Banco Itaú BBA.

12. Head of Project Finance Energy at Banco Security.

13. General Manager at Anabática Renovables.

Renewable energy private sector executives

14. Chilean Association of Renewable Energy (in Spanish *Asociación Chilena de Energías Renovables*, ACERA).

15. CEO of SunEdison Chile, and President and Founder of the Chilean Association of Renewable Energy (ACERA).

16. CEO of Acciona Energía Chile, Vice-president and Founder of the Chilean Association of Renewable Energy (ACERA).

17. Product Manager Solar at ABB Chile.

18. Director of Government Affairs, Latin-America, at First Solar. Before: Head of the Technical Division at the Chilean Renewable Energy Center (in Spanish *Centro de Energías Renovables*, CER).

19. CEO at GPE (Generadora de Proyectos Elétricos), private company that designs and owns small run-of-river hydropower plants.

20. Renewable Energy, Wind Project Manager at Enel Green Power Chile.

21. CEO at AKKTEI, private company that designs and owns small run-of-river hydropower plants. Before: Founder of the Chilean Association of Small and Medium Size Hydroelectric Generation Plants (in Spanish *Asociación de Pequeñas y Medianas Centrales Hidroeléctricas*, APEMEC).

22. Owner and CEO at Parque Eólico Las Peñas (Las Peñas Wind Farm), small wind farm in Southern Chile.

23. Power Sales Manager at Mainstream Renewable Power, the company that is considered to have win the last tender that Chile held in July were they were adjudicating 1/3 of the regulated customers at the SIC and SING electricity systems (that correspond to 99% of the Chilean electricity market).

Traditional private sector executives

24. Executive Vice-president (and public representative) of the Association of Chilean Generators, which is the association of the 6 biggest generation companies of Chile.

25. Chief Business Officer at Colbún, one of the three dominant generation companies in Chile.

26. Executive Director at Empresas Eléctricas (Electric Enterprises), which is the association of Chilean transmission and distribution companies.

Experts

27. Professor at Pontificia Universidad Catolica de Chile, Director at Consultancy firm Systep.
28. Director at the Solar Energy Research Center SERC Chile, Professor at Universidad de Chile.
29. Economist specialized in energy affairs, Professor at Universidad de Chile.
30. Environmental activist, Professor at Universidad de Chile.
31. Professor at Universidad Alberto Hurtado, Director of the Energy and Society Research Project.
32. Professor at Universidad de Concepción, Deputy Director and Consultant at the regulatory institution CDEC-SIC (independent grid operator for the SIC).
33. Associate Director at the Solar Energy Research Center SERC Chile, Professor at Universidad de Concepción.
34. Lawyer, previously worked at the Chilean Ministry for the Environment, including at the Environmental Impact Evaluation Unit (SEA).

Environmental advocacy groups

35. Director of NGO Chile Sustentable (Sustainable Chile). Probably the most relevant environmental activist in Chile, was also a presidential candidate in the 90s. Active in campaigning for passing renewable energy laws at congress.
36. Director of Greenpeace Chile.
37. Director of the NGO Ecosystems.
38. Environmental Activist, Director of movement Patagonia Sin Represas (Patagonia without dams).
39. Executive Director of the NGO Chile Ambiente Corporation.

Congress people

40. Senator, very active on environmental issues.

German Society for International Cooperation (GIZ)

41 Director of the Program for Renewable Energy and Energy Efficiency at the GIZ Chile.

42 Professional Training Program in Renewable Energy, GIZ Chile.

43 Director of the Fraunhofer Chile Research Center for Solar Energy Technologies.

Regulatory agency CDEC

44 Director of Planning and Development at the CDEC-SING (Load Economic Dispatch Center, an independent grid operator for the SING, which is the electricity system of Northern Chile).

45 Executive Director at the CDEC-SIC (independent grid operator for the SIC, which is the electricity system of Central and Southern Chile).

APPENDIX B. INTERVIEW PROTOCOLS

The data collection process related to the interviews was conducted during the time period comprised between June to August 2016 in Chile, in Santiago the Chile (capital) and Concepcion (second largest Chilean city). It comprised 45 in-depth interviews to stakeholders and experts from the energy sector. Interviews were semi-structured and varied according to the different interviewee categories considered. The study attempted to cover stakeholders from all over the spectrum of actors, including high-level government officials, environmental NGO activists, experts from universities and research centers, private sector executives from both the NCRE and traditional sectors, financial sector executives, and parliamentarians. Interview protocols by interviewee category are listed below.

<u>Questionnaires by interviewee categories</u>

(1) Government officials (from ministries and other governmental agencies)

1. Why did the government start to push and encourage the transition to the use of renewables in Chile?
2. What has been the role played by the government [Ministry of Energy, Ministry of the Environment, Chilean Development Agency] in the transition?
3. What are the goals of the government [Ministry of Energy, Ministry of the Environment, Chilean Development Agency] with respect to renewables? Have this goals changed through time?
4. What are the key factors —e.g. energy prices, demand projections, sustainability objectives, legislations, international trends, political and/or geopolitical interests— that have enabled this transition to happen?
5. What key stakeholders have played a central role in the transition and why have they taken action?
6. What has been the influence of international tendencies on this vision? Have specific countries played an important role?

7. What are the government's [Ministry of Energy, Ministry of the Environment, Chilean Development Agency] expectations for the transition in the future?

8. What are the main challenges that the transition to renewables will face moving forward? Why?

9. Are there any tensions between regulatory bodies and policy agencies that you think are relevant to mention?

10. What did I forget to ask you?

11. Where can I get more information (documents, reports, etc.) to document the types of things we have talked about in this interview?

(2) Development organizations (national)

1. What type of renewable energy projects are financed (or have been financed) through development agencies? Are benefits different by geographical sector? Where does the funding come from?

2. Is the funding focused on infrastructure development or technology selling, or both?

3. What are the goals and expected benefits of these initiatives?

4. Are the offered benefits/programs taken full advantage of? What factors may impede this?

5. What are the main obstacles that the development and implementation of renewable energy projects face or will face in the near future?

6. Are any technology transfer issues relevant to the energy development debate? E.g. trade policies, intellectual property rights issues.

7. What did I forget to ask you?

8. Where can I get more information (documents, reports, etc.) to document the types of things we have talked about in this interview?

(3) Financial sector executives (from national banks)

1. Why did the financial sector became interested in investing on renewables? When did this happen?

2. Why the financial sector was not interested in investing in the sector before?

3. Are financial interests clustered according to regional resource availability?

4. What are the main financial risks associated to these type of investments?

5. How profitable are energy investments on renewables compared with investments in other sectors?

6. Is the financial sector interested in financing investments in electricity generation or technology selling, or both?

7. Is the financial sector interested only in financing certain types of technologies?

8. Do you think the financial sector will remain interested on the renewable energy sector in the incoming years? What factors may affect this disposition?

9. Are any technology transfer issues relevant to the energy investment debate? E.g. trade policies, intellectual property rights issues.

10. What did I forget to ask you?

(4) Private sector executives (both from major companies and entrepreneurs)

1. Why did the private sector become interested and start investing on renewables in the country?

2. Are investment interests clustered according to regional resource availability?

3. What are the main obstacles that renewable energy projects face (and have faced)? Is this likely to improve in the near future?

4. Is the energy market in Chile interesting for investing in electricity generation or technology selling, or both?

5. What are the main risks associated with renewable energy investments?

6. What is the role that the private sector has played in the transition to renewables in Chile?

7. What are the general expectations of the private sector for the transition in the next years? What are the main obstacles that an expansion of the sector might face in the near future?

8. Are any technology transfer issues relevant to the energy investment debate? E.g. trade policies, intellectual property rights issues.

9. May I ask you if it is possible to tour your installations?

10. What did I forget to ask you?

(5) Experts (consultants, university professors)

1. What is your general impression about the transition to renewables that has taken place in Chile in the last decade?

2. What are the key factors —e.g. energy prices, demand projections, sustainability objectives, technological availability, legislations, international trends, political and/or geopolitical interests— that have enabled this transition to happen?

3. What key stakeholders have played a central role in the transition and why have they taken action?

4. What are the main challenges that the transition to renewables will face moving forward? Why?

5. Are any technology transfer issues relevant to the energy investment debate? E.g. trade policies, intellectual property rights issues.

6. Is the Chilean market interesting for investing in electricity generation or technology selling, or both?

7. What did I forget to ask you?

8. Where can I get more information (documents, reports, etc.) to document the types of things we have talked about in this interview?

(6) Environmental advocacy groups

1. What is your general impression about the transition to renewables that has taken place in Chile in the last decade?

2. What are the key factors —e.g. energy prices, demand projections, sustainability objectives, legislations, international trends, political and/or geopolitical interests— that have enabled this transition to happen?

3. What key stakeholders have played a central role in the transition and why have they taken action?

4. What has been the role played by environmental groups in the transition? Do you think you have been particularly important in certain regions of the country?

5. Why did environmental advocacy groups become interested and involved in renewable energy issues?

6. What did I forget to ask you?

(7) Congresspeople

1. What is your general impression about the transition to renewables that has taken place in Chile in the last decade?
2. How can you describe in general the reception of legislation projects that seek to push and incentivize the transition towards the use of renewable energy in the country?
3. Who has developed these legislation projects and what actors have pushed these types of reforms?
4. What are the main obstacles that these legislation projects typically face?
5. What interests are at stake when the debate on this reforms emerges?
6. Is there any ideological component associated to energy policies and debates? E.g. economic development versus sustainability, or market orientation versus community orientation.
7. What did I forget to ask you?

(8) German development agency (in Chile)

1. Since the mid-90s, Germany has been involved in the promotion of renewable energy generation in Chile, why did this interest arise? What are the goals of the German government for supporting this transition?
2. What has been the role of the German development agency in the Chilean energy transition to renewables?
3. What are the key factors —e.g. energy prices, demand projections, sustainability objectives, technological availability, legislations, international trends, political and/or geopolitical interests— that have enabled this transition to happen?
4. What key stakeholders have played a central role in the transition and why have they taken action?
5. What are the main challenges that the transition to renewables will face moving forward? Why?
6. Are any technology transfer issues relevant to the Chilean energy debate? E.g. trade policies, intellectual property rights issues.

7. There is an emerging cluster of experts and scientists in Europe, especially in Germany and the Netherlands, specializing on transitions to sustainability, are you familiarized with this research field or literature?

8. What did I forget to ask you?

(9) International development agencies (e.g. Inter-American Development Bank IDB)

1. Why did international development organizations become early interested in financing and supporting the development of the renewable energy generation sector in Chile?

2. What type of renewables projects are financed (or have been financed) through international development agencies? Do opportunities and benefits differ by geographical location?

3. Is the Chilean energy sector interesting in terms of projects in electricity generation or technology selling, or both?

4. What are the goals and expected benefits of these initiatives?

5. Are the offered benefits taken full advantage of? What factors may impede this?

6. What are the main obstacles that the development and implementation of renewable energy generation projects face or will face in the near future?

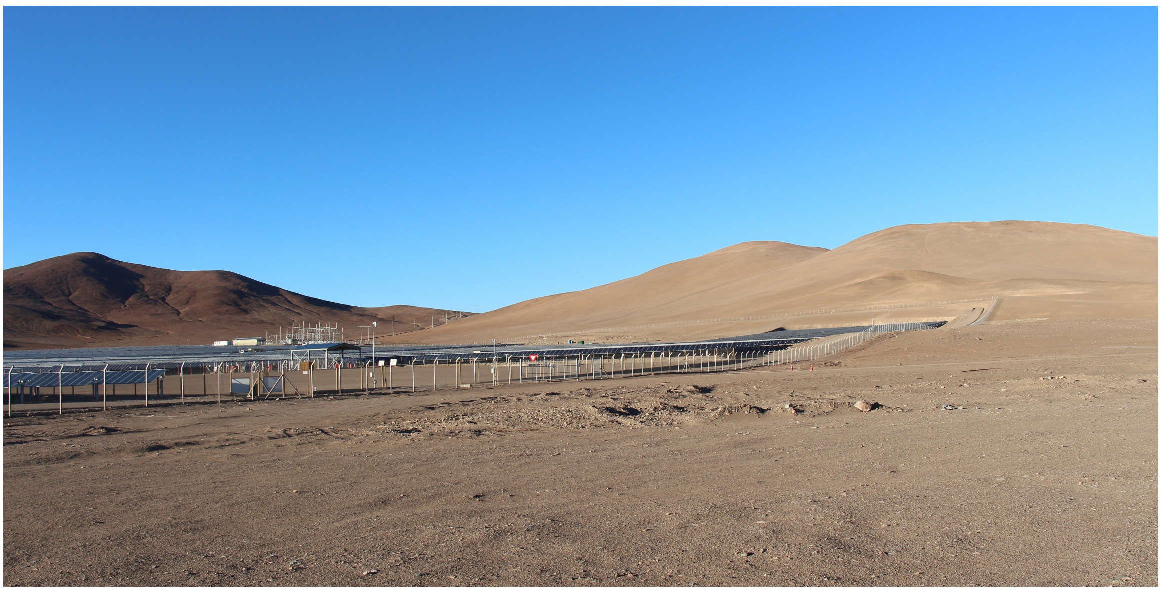
7. Are any technology transfer issues relevant to the Chilean energy debate? E.g. trade policies, intellectual property rights issues.

8. What did I forget to ask you?

9. Where can I get more information (documents, reports, etc.) to document the types of things we have talked about in this interview?

APPENDIX C. SITE VISITS

Picture 1. From my visit to solar plant PV Salvador, located in the Atacama Desert near Diego de Almagro, III Region, Chile.



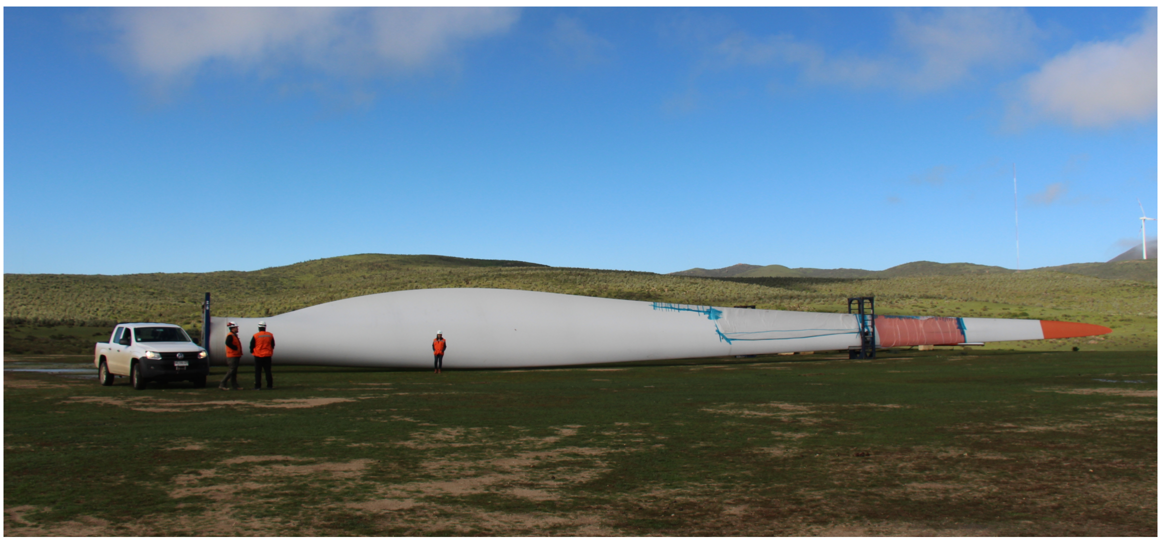
Picture 2. Solar plant Javiera, located in the Atacama Desert, III Region, Chile.

Picture 3. From my visit to solar plant PV Salvador, located in the Atacama Desert near Diego de Almagro, III Region, Chile.

Picture 4. View from the highway next to the sea near La Serena, IV Region, Chi

Picture 5. From my visit to wind farm Eólico Talinay located near La Serena, IV Region, Chile.

Picture 6. From my visit to wind farm Eólico Talinay located near La Serena, IV Region, Chile.

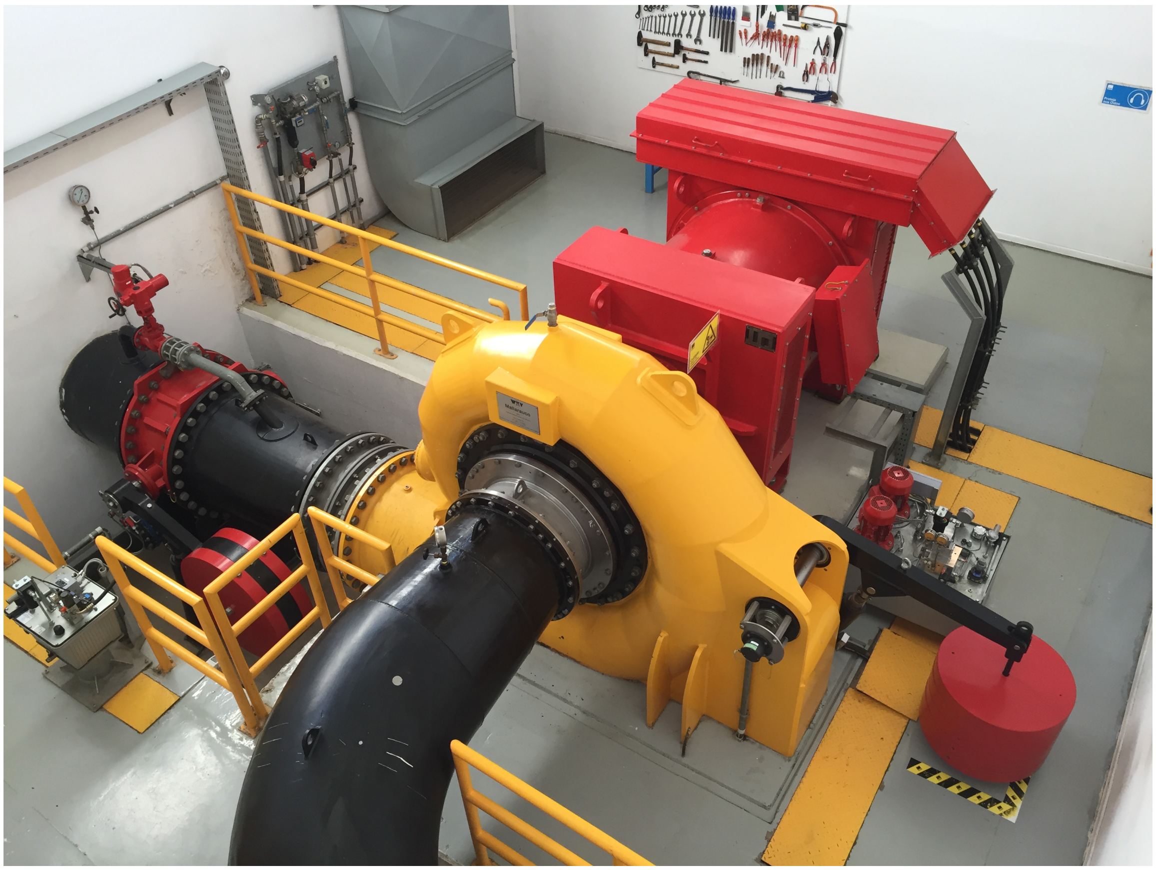


Picture 7. Of a damaged generator from 2015 earthquake in Northern Chile. Picture from my visit to wind farm Eólico Talinay located near La Serena, IV Region, Chile.

Picture 8. Visit from the high way near Los Angeles, in the VIII Region, Southern Chile.

Picture 9. Form my visit to wind farm Negrete-Cuel near Los Angeles, in the VIII Region, Southern Chile.

Picture 10. General view of the small run-of-river power plant Mallarauco in the Central valley, V region and Metropolitan region, Chile.



Picture 11. Form my visit to the small run-of-river power plant Mallarauco in the Central valley, Metropolitan Region, Chile.

REFERENCES

Anderson, P., Tushman, M., 1990. Technological discontinuities and dominant designs: a cyclical model of technological change. Administrative Science Quarterly 35, 604–633.

Assmann, D., & Uh, D. (2006). *Renewable energy: a global review of technologies, policies and markets*. Routledge.

Avelino, F., & Rotmans, J. (2009). Power in transition: an interdisciplinary framework to study power in relation to structural change. *European Journal of Social Theory*, *12*(4), 543-569.

Avelino, F., Grin, J., Pel, B., & Jhagroe, S. (2016). The politics of sustainability transitions. *Journal of Environmental Policy & Planning*, *18*(5), 557-567.

Bai, X., Wieczorek, A. J., Kaneko, S., Lisson, S., & Contreras, A. (2009). Enabling sustainability transitions in Asia: the importance of vertical and horizontal linkages. *Technological Forecasting and Social Change*, *76*(2), 255-266.

Bailey, I., 2007. Market environmentalism, new environmental policy instruments, and climate change policy in the United Kingdom and Germany. Ann. Assoc. Am. Geogr. 97 (3), 530–550.

Balat, M., Balat, H., 2009. Recent trends in global production and utilization of bio- ethanol fuel. Applied Energy 86 (11), 2273–2282.

Baumgartner, Frank R., and Bryan D. Jones. 1993. *Agendas and Instability in American Politics*. Chicago: University of Chicago Press.

Beck, F., & Martinot, E. (2004). Renewable energy policies and barriers.*Encyclopedia of energy*, *5*(7), 365-383.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. and Rickne, A., 2008, 'Analyzing the functional dynamics of technological innovation systems: A scheme of analysis', Research Policy, 37(3), 407-429.

Berkhout, F., Verbong, G., Wieczorek, A. J., Raven, R., Lebel, L., & Bai, X. (2010). Sustainability experiments in Asia: innovations shaping alternative development pathways?. *environmental science & policy*, *13*(4), 261-271.

Berkhout, F., Angel, D., & Wieczorek, A. J. (2009). Sustainability transitions in developing Asia: Are alternative development pathways likely?. *Technological Forecasting and Social Change*, *76*(2), 215-217.

Berman, Sheri. 1998. *The Social Democratic Moment: Ideas and Politics in the Making of Interwar Europe*. Cambridge MA: Harvard University Press.

Beneyto, Sylvia. (2010). Discussion on the deregulation of electricity markets. Prepared for Mines ParisTech. retrieved from http://www.energypolicyblog.com/

Bird, L., Cochran, J., & Wang, X. (2014). Wind and solar energy curtailment: experience and practices in the United States. *US National Renewable Energy Laboratory*.

Bloomberg (2016). Chile Has So Much Solar Energy It's Giving It Away for Free. Retrieved from https://www.bloomberg.com

Bloomberg New Energy Finance. (2012). "Climate Scope 2012: Assessing the Climate for Climate Investing in Latin America and the Caribbean".

Blyth, M. (2002). *Great transformations: Economic ideas and institutional change in the twentieth century*. Cambridge University Press.

Brouwer, S., & Biermann, F. (2011). Towards adaptive management: examining the strategies of policy entrepreneurs in Dutch water management. Ecology and Society, 16(4).

California Energy Commission. (2016). CaliforniaEnergyCommission – TrackingProgress. Report updated 6/24/2016. Retrieved from http://www.energy.ca.gov

California Energy Commission. (2017). Renewable Energy Transmission Initiative (RETI) 2.0 Retrieved from http://www.energy.ca.gov/reti/

Carlsson, B., Jacobsson, S., 1997a. In search of a useful technology policy—general lessons and key issues for policy makers. In: Carlsson, B. (Ed.), Technological Systems and Industrial Dy- namics. Kluwer Press, Boston, p. 315.

Carlino, H. (2016). Financiamiento para energía renovable en Chile. In Expansión de las energías renovables no convencionales en América Latina y el Caribe: El rol de las instituciones

financieras de desarrollo. Edited by a Netto, M., Cabrera, M.M., and Gomes Lorenzo, J.J. Inter-American Development Bank study.
Central Angostura. (n.d.). Website of the energy plant. Retrieved from https://centralangostura.cl/comunidad/
Country Energy Profile: Chile, Clean Energy Information Portal (www.reegle.info/countries/chile-energy-profile/CL
Comisión Ciudadana Técnico-Parlamentaria (CCTP). (2011). Chile Necesita una Gran Reforma Energética, Propuestas de la Comisión Ciudadana Técnico-Parlamentaria para la Transición hacia un Desarrollo Eléctrico Limpio, Seguro, Sustentable y Justo. Santiago, Chile. Retrieved from http://www.chilesustentable.net/
Chile Sustentable. (2003). Proyecto de Ley para la Promoción de las Energías Renovables en Chile. Santiago, Chile. Retrieved from http://www.chilesustentable.net/
Christensen, C., 1997. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail. Harvard Business School Press, Boston, MA.
Comisión Asesora para el Desarrollo Eléctrico (CADE). (2011). Final report presented in November 2011 elaborated for the Government of Chile and the Ministry of Energy. Santiago de Chile, Chile.
Comisión Nacional de Energía (CNE), Government of Chile (2008). Política Energética: Nuevos Lineamientos. Retrieved from https://www.cne.cl/
Comisión Nacional de Energía (CNE), Ministry of Energy, Government of Chile (2015). Energy Statistical Yearbook Chile. Retrieved from https://www.cne.cl/
Comisión Nacional de Energía (CNE). (2003). "Fijación de precios Nudo: Sistema Interconectado Central (SIC). Informe técnico definitivo".
Comisión Nacional de Energía (CNE), Ministry of Energy, Government of Chile. (2017). Reporte mensual ERNC. Volumen Nº9. Mayo 2017.
Cordero, L., Martinez, D. and Poduje, I. (2015). Políticas Nacionales, Territorios Regionales: Propuestas para un ordenamiento territorial en energía. Espacio Público. Santiago, Chile. Retrieved from http://www.espaciopublico.cl/
Cuentas Ramírez, S. (2014). Diario El País. "Nicolasa Quintremán y el territorio sagrado del Bío Bío." Retrieved from http://elpais.com/elpais/2014/02/20/planeta_futuro/1392913018_924314.html
Davies, A., 1996. Innovation in large technical systems: the case of telecommunications. Industrial and Corporate Change 5 (4), 1143–1180.
Denters, B., O. van Heffen, J. Huisman and P.-J. Klok (eds). 2003. *The Rise of Interactive Governance and Quasi-Markets*. Dordrecht: Kluwer.
Di Lucia, L., & Ericsson, K. (2014). Low-carbon district heating in Sweden–Examining a successful energy transition. *Energy Research & Social Science*, *4*, 10-20.
DECC. (2011). 'Huhne heralds green energy upheaval', Financial Times, 15th December 2010, p.16. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48129/2176-emr-white-paper.pdf
Dryzek, J. S. (2001). Legitimacy and economy in deliberative democracy. Political theory, 651-669.
Dryzek, J.S., Hunold, C., Schlosberg, D., Downes, D., Hernes, H.-K., 2002. Environmental transformation of the state: the US, Norway, Germany and the UK. Pol. Stud. 50 (4), 569–682.
Eyerman, R., & Jamison, A. (1991). *Social movements: A cognitive approach*. Penn State Press, University Park, PA, 1991.
Eyestone, R. (1978). From social issues to public policy. New York, NY: John Wiley and Sons.
Escenarios 2030. (2014). Report "Escenarios Energéticos Chile 2030". Retrieved from http://escenariosenergeticos.cl/
Estrategia. (2016). 63% Caen Precios Promedio de Energía por Fuerte Competencia en Licitaciones Eléctricas. Diario Estrategia. July 12, 2016. Retrieved from http://www.estrategia.cl/13271/Titulo
Financial Times. (2010). 'Huhne heralds green energy upheaval', Financial Times, 15th December 2010, p.16.

Freeman, C., Perez, C., 1988. Structural crisis of adjustment, business cycles and investment behaviour. In: Dosi, G., Freeman, C., Nelson, R., Silverberg, G., Soete, L. (Eds.), Technical Change and Economic Theory. Pinter, London, pp. 38–66.

Freeman,C.,Louca, F., 2001. As Time Goes By: From the Industrial Revolutions to the Information Revolution. Oxford Unversity Press, Oxford.

Finat Díaz, C. (2015). Chile, a case of market-driven transition to renewables. Private Sector & Development, Pag. 16-19. Retrieved from http://www.proparco.fr/

Fischer, F. (2003). Reframing public policy: Discursive politics and deliberative practices. Oxford University Press.

Fischer, F. (2009). Democracy and expertise: Reorienting policy inquiry. Oxford University Press.

Flakus (2016). Texas Leads US in Use of Renewable Energy. Retrieved from http://www.voanews.com/a/texas-leads-us-in-use-of-renewable-energy/3565024.html

Font, N., & Subirats, J. (2010). Water management in Spain: the role of policy entrepreneurs in shaping change. Ecology and Society, 15(2).

Fox-Penner, P. (2014). *Smart Power Anniversary Edition: Climate Change, the Smart Grid, and the Future of Electric Utilities*. Island Press.

Gaede, J., & Meadowcroft, J. (2015). A Question of Authenticity: Status Quo Bias and the International Energy Agency's World Energy Outlook. *Journal of Environmental Policy & Planning*, 1-20.

Gallagher, K. S., Grübler, A., Kuhl, L., Nemet, G., & Wilson, C. (2012). The energy technology innovation system. *Annual Review of Environment and Resources*, *37*, 137-162.

Gan, D., Feng, D., & Xie, J. (2013). *Electricity markets and power system economics*. CRC Press.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research policy*, *36*(3), 399-417.

Geels, F.W. (2002) 'Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study', Research Policy, 31(8- 9), 1257-1274.

Geels, F.W. and Schot, J. (2010) *The dynamics of transitions: a socio-technical perspective*. In: Grin, John, Rotmans, Jan and Schot, Johan (eds.) Transitions to sustainable development: new directions in the study of long term transformative change. Routledge, pp. 11-104.

Geels, F.W., 2011, 'The multi-level perspective on sustainability transitions: Responses to seven criticisms', Environmental Innovation and Societal Transitions, 1(1), 24-40.

Geels, F. W., & Verhees, B. (2011). Cultural legitimacy and framing struggles in innovation journeys: a cultural-performative perspective and a case study of Dutch nuclear energy (1945–1986). *Technological Forecasting and Social Change*, *78*(6), 910-930.

Geels, F. (2014). Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective, Theory Cult. Soc. 31 (5) (2014) 21–40.

Geels, F. W., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylan, J., ... & Wassermann, S. (2016). The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014). Research Policy, 45(4), 896-913.

Genus, A., & Coles, A. M. (2008). Rethinking the multi-level perspective of technological transitions. *Research policy*, *37*(9), 1436-1445.

Gee, S., McMeekin, A., 2011. Eco-innovation systems and problem sequences: the contrasting cases of US and Brazilian biofuels. Industry and Innovation 18 (3), 301–315.

Giddens, A. (2009). The Politics of Climate Change, Polity Press, Cambridge.

Goldemberg, J., 2007. Ethanol for a sustainable energy future. Science 315 (5813), 808–810.

Goldfinch, Shaun, and Paul Hart. 2003. "Leadership and Institutional Reform: Engineering Macroeconomic Policy Change in Australia." *Governance* 16: 235–70.

Gollagher, M., & Hartz-Karp, J. (2013). The role of deliberative collaborative governance in achieving sustainable cities. *Sustainability*, *5*(6), 2343-2366.

Golob, Stephanie. 2003. "Beyond the Policy Frontier: Canada, Mexico, and the Ideological Origins of NAFTA." *World Politics* 55 (3): 361-398.

Greener, Ian. 2001. “Social Learning and Macroeconomic Policy in Britain.” *Journal of Public Policy* 21 (2): 133–152.
Hadfield (2008) A. Hadfield, Energy and foreign policy: EU-Russia energy dynamics, in: S. Smith, A. Hadfield, T. Dunne (Eds.), Foreign Policy: Theories, Actors, Cases, Oxford University Press, Oxford, 2008.
Hajime, Sato. 1999. “The Advocacy Coalition Framework and the Policy Process Analysis: The Case of Smoking Control in Japan.” *Policy Studies Journal* 27: 28–44.
Hall (1993). P.A. Policy paradigms, social learning, and the state: the case of economic policymaking in Britain, Comp. Polit. 25 (3) (1993) 275–296.
Hall, P.A., Soskice, D., 2001. Varieties of Capitalism: The Institutional Foundations of Comparative Advantage. Oxford University Press, Oxford.
Hall, S., Román, R., Cuevas, F., & Sánchez, P. (2009). ¿Se necesitan represas en la Patagonia. Ocho Libro Editores.
Hay, C, 1996, Narrating crisis:The discursive construction of the winter of discontent, Sociology,30,2, 253–77
Hay, C. (1999). Crisis and the structural transformation of the state: interrogating the process of change. *The British Journal of Politics and International Relations*, *1*(3), 317-344.
Hay, C, 2001,The crisis of keynesianism and the rise of neoliberalism in Britain:An ideational institutionalist approach, in Campbell, JL, Pedersen, OK (eds), The rise of neoliberalism and institutional analysis, Princeton, NJ: Princeton University Press
Hendriks, C.M., 2009, ‘Policy design without democracy? Making democratic sense of transition management’, *Policy Sciences*, 42(4), 341-368.
Hendriks, C. M. (2008). On inclusion and network governance: the democratic disconnect of Dutch energy transitions. *Public Administration*, *86*(4), 1009-1031.
Hermansen, E. A. (2015). Policy window entrepreneurship: the backstage of the world’s largest REDD+ initiative. *Environmental Politics*, *24*(6), 932-950.
Hervé, D. (2011). Las causas del conflicto por la central termoeléctrica de Barrancones en Punta de Choros. Anuario de Derecho Púbico, Facultad de Derecho, Universidad Diego Portales. Pages 189-208. Santiago de Chile.
Hess, D., 2007. Alternative Pathways in Science and Industry. MIT Press, Cambridge, MA.
Hess, D., 2009. Localist Movements in a Global Economy. MIT Press, Cambridge, MA.
Hess, D., 2012. Good Green Jobs in a Global Economy. MIT Press, Cambridge, MA.Hess, D. J. (2014). Sustainability transitions: A political coalition perspective. *Research Policy*, *43*(2), 278-283.
Hira, A., de Oliveira, L.G., 2009. No substitute for oil? How Brazil developed its ethanol industry. Energy Policy 37 (6), 2450–2456.
Hirsh, R. (1989). Technology and Transformation in the American Electric Power Industry.
Hirsh, R. F. (2003). *Technology and transformation in the American electric utility industry*. Cambridge University Press.
Hogan, J., & Feeney, S. (2012). Crisis and policy change: the role of the political entrepreneur. *Risk, Hazards & Crisis in Public Policy*, *3*(2), 1-24.
Howlett, M., Ramesh, M., & Perl, A. (1995). *Studying public policy: Policy cycles and policy subsystems* (Vol. 3). Toronto: Oxford University Press.
Hughes, T. P. (1983). Networks of Power: Electric supply systems in the US, England and Germany, 1880-1930. *Baltimore: Johns Hopkins University*.
Hughes, L., 2012. Climate converts: institutional redeployment and public investment in energy and environment in Japan. J. East Asian Stud. 12 (1), 89–118.
Huitema, D., Lebel, L., & Meijerink, S. (2011). The strategies of policy entrepreneurs in water transitions around the world. *Water policy*, *13*(5), 717-733.
Infante, C. (2015). Totoral: La energía en nuestras manos. El triunfo de la vida sobre termoeléctrica Castilla. Santiago de Chile.
Instituto Nacional de Derechos Humanos (INDH). (2015). Mapa de Conflictos Socioambientales en Chile. Retrieved from http://mapaconflictos.indh.cl/

Instituto Nacional de Derechos Humanos (INDH). (2012). Mapa de Conflictos Socioambientales en Chile. Retrieved from http://mapaconflictos.indh.cl/

International Energy Agency and OECD. (2009). Chile: Energy Policy Review. Retrieved from https://www.iea.org/

International Renewable Energy Agency (IRENA). (2015). Chile: Reneable Energy Policy Brief. Retrieved from http://www.irena.org/Publications

Jacobsson, S., & Bergek, A. (2004). Transforming the energy sector: the evolution of technological systems in renewable energy technology. Industrial and corporate change, 13(5), 815-849.Levinthal, 1998

Jacobsson, S., & Lauber, V. (2006). The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy policy*, *34*(3), 256-276.

Jacobsson, S., & Bergek, A. (2011). Innovation system analyses and sustainability transitions: Contributions and suggestions for research.*Environmental Innovation and Societal Transitions*, *1*(1), 41-57.

Joskow, P. L., & Schmalensee, R. (1983). Markets for power: An analysis of electrical utility deregulation. *MIT Press Books*, *1*.

Joskow, P. L. (2008). Lessons learned from electricity market liberalization. *The Energy Journal*, *29*(2), 9-42.

Infante Correa, E. (2015). “Totoral: La energía en nuestras manos. El triunfo de la vida sobre termoeléctrica Castilla”. Observatorio Latinoamericano de Conflictos Ambientales OLCA. Santiago de Chile.

International Energy Agency (IEA). (2016). Re-Powering markets: Market design and regulation during the transition to low-carbon power systems.

International Energy Agency (IEA). (2016). United Kingdom profile. Retrieved from https://www.iea.org

International Energy Agency and OECD. (2009). Chile: Energy Policy Review. Retrieved from https://www.iea.org/

Karan, M. B., & Kazdağli, H. (2011). The development of energy markets in Europe. In *Financial Aspects in Energy* (pp. 11-32). Springer Berlin Heidelberg.

Kemp, R., Rotmans, J., & Loorbach, D. (2007). Assessing the Dutch energy transition policy: how does it deal with dilemmas of managing transitions?*Journal of Environmental Policy & Planning*, *9*(3-4), 315-331.

Kemp, R; Loorbach, D (2003). "Governance for sustainability through transition management.” *IHDP-conference*.

Kemp, R. (2011). The Dutch energy transition approach. In *International Economics of Resource Efficiency* (pp. 187-213). Physica-Verlag HD.

Kenis, A., Bono, F., & Mathijs, E. (2016). Unravelling the (post-) political in Transition Management: Interrogating Pathways towards Sustainable Change. Journal of Environmental Policy & Planning, 1-17.

Kern, F., & Howlett, M. (2009). Implementing transition management as policy reforms: a case study of the Dutch energy sector. *Policy Sciences*, *42*(4), 391-408.

Kern, F., 2011, ‘Ideas, institutions and interests: Explaining policy divergence in fostering ‘system innovations’ towards sustainability’, Environment and Planning C: Government and Policy, 29(6), 1116-1134.

Kern, F., Kuzemko, C., & Mitchell, C. (2014). Measuring and explaining policy paradigm change: the case of UK energy policy. *Policy & Politics*, *42*(4), 513-530.

Kemp, R., Rotmans, J. and Loorbach, D., 2007, 'Assessing the Dutch energy transition policy: How does it deal with dilemmas of managing transitions?', Journal of Environmental Policy and Planning, 9(3-4), 315-331.

Kingdon, John W. [1984] 1995. *Agendas, Alternatives, and Public Policies*, 2nd ed. Boston: Little, Brown & Company.

Kronsell, A., Hildinsson, R., & Khan, J. (2012, March). Participation and deliberation in low-carbon transition governance: Learning from climate policy making in Sweden. In IST2012.

Kuzemko, C., Lockwood, M., Mitchell, C., & Hoggett, R. (2016). Governing for sustainable energy system change: Politics, contexts and contingency. Energy Research & Social Science, 12, 96-105.

Laird, F. N., & Stefes, C. (2009). The diverging paths of German and United States policies for renewable energy: Sources of difference. *Energy Policy*, *37*(7), 2619-2629.

Larraín, F. and Quiroz, J. (2008). Evaluación Social de la llegada del gas natural a Chile: elementos de análisis in M. Domper and C. Cortés (eds.), Gas Natural: Lecciones de una Crisis. Ediciones LyD y AGN Chile. Santiago, 2008.

Langaas et at. (2007). The concept of institutional capacity building and review of road sector projects. Norwegian Public Roads Administration, Norway. Retrieved from http://www.vegvesen.no/_attachment/112627

Lieberman, M., Montgomery, C., 1988. First mover advantages. Strategic Management Journal 9, 41–58.

Lipp, J., 2007. Lessons for effective renewable electricity policy from Denmark, Germany and the United Kingdom. Energy Policy 35 (11), 5481–5495.

Leftwich, A. (1983). *Redefining Politics: People, Resources, and Power* (Vol. 812). Taylor & Francis.

Lehtonen, M., 2007. Biofuel transitions and global governance: lessons from Brazil. Paper Presented at the Amsterdam Conference on the Human Dimensions of Global Environmental Change, 24–26 May 2007, Amsterdam. Available at: www.2007amsterdamconference.org

Leite, A.D., 2009. Energy in Brazil: Towards a Renewable Energy Dominated System. Earthscan, London.

Levy, Jack S. 1994. "Learning and Forign Policy: Sweeping a Conceptual Minefield." International Organizatio

Litfin, Karen T. 2000. "Advocacy Coalitions along the Domestic-Foreign Frontier: Globalization and Canadian Climate Change Policy." *Policy Studies Journal* 28: 236–52.

Machin, A. (2013). Negotiating climate change. Radical democracy and the illusion of consensus. London: Zed Books.

McCarthy, J. and Zald, M. (1977). Resource mobilization and social movements, Am. J. Sociol. 82, 1212–1241.

Madrigal, M. and Stoft, S. (2011). Transmission Expansion for Renewable Energy Scale-Up Emerging Lessons and Recommendations. Study elaborated for the World Bank.

Maggio, David. (2013). Personal communication and ERCOT curtailment data, June 25, 2013.

Mahoney, J. and Thelen, K. (2010). A theory of gradual institutional change, in: J. Mahoney, K. Thelen (Eds.), Explaining Institutional Change: Ambiguity, Agency and Power, Cambridge University Press, Cambridge.

Markard, J., Truffer, B., 2008, 'Technological innovation systems and the multi- level perspective: towards an integrated framework', Research Policy, 37(4), 596-615.

Markard, J., Raven, R., Truffer, B., 2012, 'Sustainability transitions: an emerging field of research and its prospects', Research Policy, 41(6), 955-967.

MaRS. (2015). Market Information Report: Chile. Ontario, Canada

Mayer, B., 2008. Blue-Green Coalitions: Fighting for Safe Workplaces and Healthy Communities. ILR Press, Ithaca, NY.

Marquand, D., 2004. The Decline of the Public: The Hollowing Out of Citizenship. Polity Press, Cambridge.Kuzemko, C., Lockwood, M., Mitchell, C., & Hoggett, R. (2016). Governing for sustainable energy system change: Politics, contexts and contingency. Energy Research & Social Science, 12, 96-105.

Martinot, E. (2002) 'Grid-Based Renewable Energy in Developing Countries: Policies, Strategies, and Lessons from the GEF', Washington, DC, Global Environment Facility, presentation at World Renewable Energy Policy and Strategy Forum, Berlin, 13–15.

McCrone, A., Moslener, U., d'Estais, F., & Grüning, C. (2016). Global trends in renewable energy investment 2016. Frankfurt School UNEP Collaborating Centre for Climate and Sustainable Energy Finance.

Meadowcroft, J. (2005). Environmental political economy, technological transitions and the state. *New Political Economy*, *10*(4), 479-498.

Meadowcroft, J., 2009, 'What about the politics? Sustainable development, transition management, and long term energy transitions', *Policy Sciences*, 42(4), 323-340.

Meadowcroft, J., 2011, 'Engaging with the politics of sustainability transitions', Environmental Innovation and Societal Transitions, 1(1), 70-75.

Meijerink, Sander. 2005. "Understanding Policy Stability and Change: The Interplay of Advocacy Coali- tions and Epistemic Communities, Windows of Opportunity, and Dutch Coastal Flooding Policy 1945–2003." *Journal of European Public Policy* 12: 1060–77.

Memoria Chilena, Biblioteca Nacional de Chile, (n.d.). "Pangue y Ralco". Retrieved from http://www.memoriachilena.cl/602/w3-article-96731.html

Mesa ERNC. (2015). Mesa ERNC: Una Mirada participativa del rol y los impactos de las energías renovables en la matriz eléctrica futura. Report elaborated for the Ministry of Energy and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Santiago, Chile.

Ministry of Energy, Government of Chile. (2012). National Energy Strategy 2012-2030: Energy for the Future.

Ministry of Energy, Government of Chile. (2014). Energy Agenda. Retrieved from http://www.energia.gob.cl/

Ministry of Energy, Government of Chile. (2015). Energy 2050. Retrieved from http://www.energia2050.cl/

Ministry of Energy (Division for Renewable Energy), Government of Chile, and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2015). Expansión de Energías Renovable No Convencionales en los Sistemas Interconectados de Chile. Santiago, Chile.

Ministry of Energy, Government of Chile. (2015). Road Map to 2050: Toward a Sustainable and Inclusive Energy Future.

Mintrom, M., & Vergari, S. (1996). Advocacy coalitions, policy entrepreneurs, and policy change. *Policy studies journal*, *24*(3), 420-434.

Mintrom, M., & Norman, P. (2009). Policy entrepreneurship and policy change. Policy Studies Journal, 37(4), 649-667.

Mitchell, C., J. L. Sawin, G. R. Pokharel, D. Kammen, Z. Wang, S. Fifita, M. Jaccard, O. Langniss, H. Lucas, A. Nadai, R. Trujillo Blanco, E. Usher, A. Verbruggen, R. Wüstenhagen, K. Yamaguchi, 2011: Policy, Financing and Implementation. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Moomaw, W. R., & Tullis, M. (1994). Charting developmentpaths: a multicountry comparison of carbon dioxide emissions. *Industrial ecology and global change*, 157-173.

Moomaw, W., F. Yamba, M. Kamimoto, L. Maurice, J. Nyboer, K. Urama, T. Weir, 2011: Introduction. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C.von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Mouffe, C. (2000). The democratic paradox. London: Verso.

Negro, S. O., Alkemade, F., & Hekkert, M. P. (2012). Why does renewable energy diffuse so slowly? A review of innovation system problems. *Renewable and Sustainable Energy Reviews*, *16*(6), 3836-3846.

Newell, P., & Paterson, M. (2010). *Climate capitalism: global warming and the transformation of the global economy*. Cambridge University Press.

New York Times. (2008). Patagonia Without Dams. The Opinion Pages Editorial. Retrieved from http://www.nytimes.com/2008/04/01/opinion/01tue3.html

Nye, D. E. (1992). Electrifying America: Social meanings of a new technology, 1880-1940.

OECD. Centre for Opportunity and Equality. (2016). Income inequality remains high in the face of weak recovery. Income Inequality Update, November 2016. Retrieved from http://www.oecd.org/

Olivares, A., Almarza, D., Bauza, A., Barahona, M., Poklepovic, I., Delpino, I., Martorell,A., and Leyton, S. (2013). Guide for Management of NCRE Projects. Bilingual report elaborated for Center for Innovation and the Development of Sustainable Energy (CIFES), Government of Chile. Santiago de Chile.

Oliver, Michael J., and Hugh Pemberton. 2004. "Learning and Change in 20th- Century British Economic Policy." *Governance* 17 (3): 415–441.

Orren, Karen, and Stephen Skowronek. 1994. "Beyond the Iconography of Order: Notes for a 'New Institutionalism.'" In *Dynamics of American Politics: Approaches and Interpretations,* eds. Lawrence C. Dodd and Calvin Jillison. Boulder, CO: Westview Press, 311-330.

Pacheco, M., Ministry of Energy, Government of Chile. (2016). Incorporación de Fuentes Variables a la Matriz Energética en Chile. Presentation given by Minister of Energy Máximo Pacheco at the Centro de Estudios Públicos (CEP), in May 2016, Santiago de Chile, Chile. Retrieved from http://www.cepchile.cl/

Painter, J. (2009).Chile Faces Climate Change Challenge. BBC News. May 23, 2009. http://news.bbc.co.uk/2/hi/8058080.stm

Palma Behnke, Estévez, G. and Arias, I. (2009). Non-Conventional Renewable Energy in the Chilean Electricity Market. Report elaborated for the Comisión Nacional de Energía and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. Santiago, Chile.

Patagonia Sin Represas. (n.d.). Website of the Campaign: http://www.patagoniasinrepresas.cl/

Pollitt, M. G. (2012). The role of policy in energy transitions: Lessons from the energy liberalisation era. *Energy Policy*, *50*, 128-137.

Porter, M., 1998. Clusters and competition. New agendas for companies, governments and institutions. In: Porter, M. (Ed.), On Competition. A Harvard Business Review Book, Boston, pp. 197–287.

Randolph, J., & Masters, G. M. (2008). *Energy for sustainability: technology, planning, policy*. Island Press.

Rehman, I. H., Kar, A., Raven, R., Singh, D., Tiwari, J., Jha, R., ... & Mirza, A. (2010). Rural energy transitions in developing countries: a case of the Uttam Urja initiative in India. environmental science & policy, 13(4), 303-311. Jolly, S., Raven, R., & Romijn, H. (2012). Upscaling of business model experiments in off-grid PV solar energy in India. *Sustainability science*, *7*(2), 199-212.

Rip, A. and R. Kemp (1998), 'Technological change', in: S. Rayner and E.L. Malone (eds.), Human Choice and Climate Change, Columbus, Ohio: Battelle Press. Volume 2, pp. 327-399.

Rip, A. and R. Kemp (1998), 'Technological change', in: S. Rayner and E.L. Malone (eds.), Human Choice and Climate Change, Columbus, Ohio: Battelle Press. Volume 2, pp. 327-399.

Rodrigo, P. and Orrego, J.P. (n.d.). Patagonia Sin Represas. Ocho Libros Editores. Retrieved from http://www.patagoniasinrepresas.cl/

Rogge, K. S., & Reichardt, K. (2016). Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Research Policy* 45, 1620-1635.

Rotmans, J., R. Kemp & M. van Asselt (2001), 'More evolution than revolution: Transition management in public policy', Foresight, 3(1), 15-31.

Sabatier, P.A., 1998. The advocacy coalition framework: revisions and relevance for Europe. Journal of European Public Policy 5 (1), 98–130.

Sabatier, P. A., & Weible, C. (Eds.). (2014). Theories of the policy process. Westview Press.

Sagar, A., & Majumdar, A. (2014). *Facilitating a Sustainability Transition in Developing Countries. Proposal for a global Advanced Research Project Agency for Sustainable Development* (No. 3). Rio+ 20 Working Paper.

Santana, C. (2014). Energías Renovables en Chile. El potencial eólico, solar e hidroeléctrico de Arica a Chiloé. Report elaborated for the Ministry of Energy and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Santiago, Chile.
Sayer, A., 1992. Method in Social Science: A Realist Approach. Routledge, London.
Schot, J.W. and Geels, F.W., 2008, 'Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda and policy', Technology Analysis & Strategic Management, 20(5), 537-554
Shove, E. and Walker, G., 2010, 'Governing transitions in the sustainability of everyday life', *Research Policy*, 39(4), 471-476. Cohen, M.J. (2010). "Destination unknown: Pursuing sustainable mobility in the face of rival societal aspirations," *Research Policy* 39(4): 459-470.
Shwom, R., (2011). A middle-range theory of energy politics: the struggle for energy- efficient appliances. Environmental Politics 20, 705–726.
Simmons, R. T., Yonk, R. M., & Thomas, D. W. (2011). Bootleggers, Baptists, and political entrepreneurs: key players in the rational game and morality play of regulatory politics. *The Independent Review*, *15*(3), 367-381.
Sioshansi FP (2006) Electricity market reform: what have we learned? what have we gained? Electr J 19(9):70–83
Smith, M.A., 2000. Policy networks and advocacy coalitions explaining policy change and stability in UK industrial pollution policy? Environment and Planning C:Government and Policy 18, 95–118.
Smith, J.A. (1991). The idea brokers: Think tanks and the rise of the new policy elite. New York, NY: The Free Press.
Smith, M.A., 2000. Policy networks and advocacy coalitions explaining policy change and stability in UK industrial pollution policy? Environment and Planning C: Government and Policy 18, 95–118.
Smith, A., Stirling, A., and Berkhout, F., 2005, 'The governance of sustainable socio-technical transitions', Research Policy, 34(10), 1491-1510.
Smith, A., Jan-Peter Voβ, J.-P., and Grin, J., 2010, 'Innovation studies and sustainability transitions: The allure of a multi-level perspective and its challenges', Research Policy, 39(4), 435-448.
Smith, A., & Stirling, A. (2010). The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecology and Society*, *15*(1), 11.
Smith, A., & Raven, R. (2012). What is protective space? Reconsidering niches in transitions to sustainability. Research policy, 41(6), 1025-1036.
Solomon, B. D., & Krishna, K. (2011). The coming sustainable energy transition: History, strategies, and outlook. *Energy Policy*, *39*(11), 7422-7431.
Stenzel, T., & Frenzel, A. (2008). Regulating technological change—the strategic reactions of transfe companies towards subsidy policies in the German, Spanish and UK electricity markets. *Energy Policy*, *36*(7), 2645-2657.
Stone, DA, 1989, Causal stories and the formation of policy agendas, Political Science Quarterly, 104, 2, 281–300
Strange. 1998. States and Markets, Pinter, London.
Swilling, M., Musango, J., & Wakeford, J. (2016). Developmental states and sustainability transitions: prospects of a just transition in South Africa. *Journal of Environmental Policy & Planning*, *18*(5), 650-672.
Texas Wide Open for Business. (2014). The Texas Renewable Energy Industry. Retrieved from www.texaswideopenforbusiness.com
Torrens, J. (2016). Transitions studies and developing countries – does it fit? Retrieved from https://phdsintransitions.wordpress.com
Turner, G. and Astudillo, A. (2014). "Máximo Pacheco: "Para tener una estrategia energética necesitamos validarla socialmente"". Diario La Tercera. Retrieved from http://www.latercera.com/noticia/maximo-pacheco-para-tener-una-estrategia-energetica-necesitamos-validarla-socialmente/

United Nations Development Programme UNDP. (2015). Human Development Report, Human Development Index and its components. Retrieved from http://hdr.undp.org/en/composite/HDI

Universidad de Chile and Universidad Técnica Federico Santa María (2008). Potential contribution of non-conventional renewable energy sources and energy efficiency to the electricity mix, 2008-2025. In Spanish:

Unruh, G.C, 2000. Understanding carbon lock-in. Energy Policy 28, 817–830.

US Energy Information Administration (EIA). (2014). Fewer wind curtailments and negative power prices seen in Texas after major grid expansion. Retrieved from http://www.eia.gov/todayinenergy/detail.php?id=16831

US Department of Commerce - International Trade Administration (ITA). (2013). Chile's Renewable Energy and Energy Efficiency Market: Opportunities for US Exporters.

US Department of Commerce - International Trade Administration (ITA). (2014). Renewable Energy Top Markets Report. Chile.

US Department of Commerce - International Trade Administration (ITA). (2015). Renewable Energy Top Markets Report. Chile.

US Department of Commerce - International Trade Administration (ITA). (2016). Renewable Energy Top Markets Report. Country Case Study: Chile.

van den Bergh, J.C.J.M., Truffer, B. and Kallis, G., 2011, 'Environmental innovation and societal transitions: Introduction and overview', Environmental Innovation and Societal Transitions, 1(1), 1-23.

van de Poel, I. (2003), 'The transformation of technological regimes', Research Policy, 32(1), 49-68.

Van de Ven, A., Garud, R., 1989. A framework for understanding the emergence of new industries. Research on Technological Innovation, Management and Society 4, 195–225.

Verbong, G., & Geels, F. (2007). The ongoing energy transition: lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004).*Energy policy*, *35*(2), 1025-1037.

Verbong, G., & Loorbach, D. (2012). Introduction, in: G. Verbong, D. Loorbach (Eds.), Governing the Energy Transition: Reality Illusion or Necessity?, Routledge, Oxford and New York, 2012.

von Hatzfeldt, S. (2013). Renewable energy in Chile: barriers and the role of public policy. *Journal of International Affairs*, *66*(2), 199.

Wikipedia. Chile. (2016). Retrieved December 1, 2016, from https://es.wikipedia.org/wiki/ Chile

Wikipedia. Tratados de libre comercio de Chile. (2016b). Retrieved December 1, 2016, from https://es.wikipedia.org/wiki/Tratados_de_libre_comercio_de_Chile

Wikipedia. Central hidroeléctrica de Pangue. (2017). Retrieved January 1, 2017, from https://es.wikipedia.org/wiki/Central_hidroel%C3%A9ctrica_de_Pangue

Wikipedia. Central hidroeléctrica Ralco. (2017b). Retrieved January 1, 2017, from https://es.wikipedia.org/wiki/Central_hidroel%C3%A9ctrica_Ralco

Willems, S., Baumert, K., 2003. Institutional Capacity and Climate Actions. International Energy Agency Environment Directorate.

Wolff, E. (2014). Last line energized, $6.8B Texas CREZ project is complete, SNL News, February 3, 2014. http://www.snl.com/InteractiveX/Article.aspx?id=26708514

Woodhouse, S. (2011). Renewable Energy Potential of Chile. Global Energy Network Institute. California, US.

Woo CK, Lloyd D, Tishler A (2003) Electricity market reform failures: UK, Norway, Alberta and California. Energy Policy 31(11):1103–1115

Yandle, B. (1983). Bootleggers and baptists-the education of a regulatory economists. *Regulation*, *7*, 12.

Yapp, R. (2012). Renewable Energy World Magazine, "Chile's Uncertain Renewable Energy Future". Retrieved from http://www. renewableenergyworld.com

Young, O.R., 2002. The Institutional Dimensions of Environmental Change: Fit, Interplay, and Scale. MIT Press.